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THE PHILIPPINE
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VOL. 69 MAY, 1939 No. 1

NOTES ON THE pH MEASUREMENT OF NATURAL WATERS

By RUSTICO TENGCO
Of the Metropolitan Water District, Manila

In the purification of natural water, pH measurement has become one of the important factors that have placed the processing of water supplies on a scientific basis. On account of its simplicity and rapidity the colorimetric method of pH determination has been widely adopted. This method, however, is subject to a number of limitations. Unless the "isohydric technic"(1) is used, an indicator solution will affect the original pH value of a very dilute or weakly buffered solution. Salt, colloid, protein, and solvent effects are likely to introduce specific errors dependent on the nature of the unknown solution. Personal error, inherent in the photometric method involved, will also influence the results.

In the colorimetric pH measurement of the Manila water supply the error due to "indicator and salt effects" is probably most significant when the usual procedure of Clark(5) is followed. Since the salt concentration of our water is approximately 0.001N (as $CaCO_3$), it would be desirable to determine the effect of the indicator solution on the pH of the water and the salt effect, on account of the difference in salt concentration between the water and the buffer solution (0.1 N) used for the color standards.(7) The "indicator effect" can be determined by using indicator solutions of adjusted pH values, while the salt effect can be evaluated by comparing the electrometric and the colorimetric pH values of water samples. For the latter the procedure should be a direct comparison with the hydrogen electrode, but Burton(4) has shown that due to the slight buffering characteristics of natural waters the hydrogen electrode is inapplicable; however, these same investigators found that the glass electrode gave the most reliable results with natural and treated waters. The glass electrode was therefore chosen for the electrometric method. Other methods of evaluating salt errors from indicator dissociation constants and absorption indices are given respectively by Kilpatrick(6) and Wingfield.(8)

EXPERIMENTAL PROCEDURE

Water samples were obtained from different points along the course of the water being treated at the Balara Filtration Plant. The colorimetric apparatus consisted of a La Motte Roulette comparator and color standards. Indicator solutions were prepared from La Motte indicator powders. The glass electrode was a Coleman pH Electrometer Model 3D. Based on actual tests, under ordinary laboratory conditions, the precision of this electrometer was well within ± 0.05 pH, exclusive of any error in the buffer reference solution. The adjustment of the pH values of the indicator solutions was made with the glass electrode. No attempt has been made to observe extreme refinement in the measurements made, such as elimination of CO_2 interference and temperature variations.

RESULTS

The results of comparative tests between the colorimetric and glass electrode pH measurements are shown in Tables 1 and 2. The salt concentrations were based on the total alkalinity of the water samples, expressed as $CaCO_3$.

In Table 1 the colorimetric tests were made with the pH of the indicator solutions (phenol red and brom thymol blue), adjusted to the values given. The results in Table 1 show no appreciable variation in pH value of a given water sample when tested with these adjusted indicator solutions; in other words, the effect of the indicator on the pH of the sample is negligible. These results are in agreement with the findings of Acree and Fawcett(1) who showed that up to 1 : 50 dilution of 0.05 M buffer solutions no appreciable changes in pH of the diluted solutions occur when tested with adjusted indicator solutions. It can therefore be stated that the adjustment of the indicator solution is unnecessary in the colorimetric pH measurement of natural and treated waters. Using adjusted in-

TABLE 1.—*Results of comparative tests with colorimetric and glass electrode pH measurement, with the pH of the indicator solutions adjusted.*

Water sample.	Alkalinity as $CaCO_3$.	Salt concentration.	Glass electrode.	Colorimetric pH values.							
				Phenol red.					Brom thymol blue.		
				Solution 1, pH 6.8.	Solution 2, pH 7.1.	Solution 3, pH 7.4.	Solution 4, pH 7.7.	Solution 5, pH 7.9.	Solution 1, pH 6.4.	Solution 2, pH 6.7.	Solution 3, pH 7.2.
	p. p. m.		*pH.*								
1	35	0.0007*N*	8.1	7.7	7.7	7.7+	7.8—	7.8—	----	----	----
2	28	0.0006*N*	7.1	6.8	6.8	6.8+	6.9—	6.9—	6.9	6.9	6.9+
3	31	0.0006*N*	7.4	7.1	7.1	7.1+	7.2	7.2	7.1	7.1+	7.1+
4	30	0.0006*N*	7.6	7.3	7.3	7.3+	7.4—	7.4—	7.3	7.3	7.3+
5	30	0.0006*N*	7.4	7.1	7.1	7.1+	7.2—	7.2—	7.1	7.1	7.1+
6	120	0.0024*N*	8.0	7.8—	7.8—	7.8—	7.8	7.8	----	----	----
7	110	0.0022*N*	7.5	7.3	7.3	7.3	7.3+	7.3+	7.3+	7.4—	7.4—
8	64	0.0013*N*	7.4	7.1+	7.1+	7.2	7.2	7.2	7.2—	7.2—	7.2
9	54	0.0013*N*	7.8	7.4+	7.4+	7.4+	7.5	7.5	7.5+	7.5+	7.6
10	64	0.0013*N*	7.5	7.2	7.2+	7.2+	7.5	7.3	7.3	7.3	7.3+

dicator solutions, Black et al.(2) reported significant variations in the pH of the "synthetic" water they used for laboratory coagulation experiments. He remarked, however, that "it should not be inferred that the variations will be as great in the case of natural and treated waters."

TABLE 2.—*Results of comparative tests with colorimetric and glass electrode pH measurements, with the pH of the indicator solutions unadjusted.*

Water sample.	Alkalinity as $CaCO_3$.	Salt concentration.	Glass electrode.	Phenol red.	Brom thymol blue.
	p.p.m.		*pH.*		
1	120	0.0021*N*	8.1	7.8	----------
2	110	0.0022*N*	7.5	7.3—	7.3
3	50	0.001 *N*	7.4	7.1	7.1+
4	51	0.001 *N*	7.7	7.4	7.4
5	51	0.001 *N*	7.5	7.1	7.1+
6	40	0.0008*N*	7.6	7.2	7.2+

Tables 1 and 2 which give the glass electrode and colorimetric pH values of the different water samples show considerable differences between these values, ranging from 0.2 to 0.4 pH units. In all the samples tested, the colorimetric values were lower than the glass electrode values. If the glass electrode were assumed to behave like a hydrogen electrode, the differences in the pH values may be attributed to the salt effect of the indicators used. Apparently contradicting the above results, Burton et al.(4) reported "isohydric" colorimetric pH values of a tap water, and a M/100,000 sodium hydrogen phthalate buffer, which were slightly higher than the glass electrode values. However, details of the colorimetric procedure and salt error corrections were not given.

Corrections for salt errors of phenol red and brom thymol blue, as given by Britton(3) are shown in Table 3. The positive corrections mean that these figures should be added to the colorimetric value for the corresponding salt concentration. Although the salts present in natural waters are not similar to those used in obtaining the corrections in Table 3, the magnitude of the difference found between the two methods is close to the correction corresponding to similar electrolyte concentration.

TABLE 3.—*Corrections for salt errors of indicators at low electrolyte concentration in relation to Clark's buffer solutions.*

Total concentration.	Phenol red.	Brom thymol blue.
0.001*N*	+0.35	+0.19
0.005*N*	+0.28	+0.17
0.01*N*	+0.22	+0.15
0.02*N*	+0.15	+0.12
0.03*N*	+0.09	----------

SUMMARY AND CONCLUSION

It has been shown that the adjustment of indicator solutions for ordinary colorimetric pH measurements in natural waters is not as necessary as has been claimed by some workers. Colorimetric pH values of the Manila water supply were lower than the glass electrode values by 0.2 to 0.4 pH units. This difference may be attributable to the salt error of the indicators used. A preliminary comparison between the colorimetric and electrometric pH values should be considered if reliable colorimetric data is desired. For the purpose of uniformity and comparison, the method used in making pH measurements should be specified.

ACKNOWLEDGMENT

The author is grateful to Mr. A. Magsaysay, Manager of the Metropolitan Water District, Manila, for permission to publish this report; and to Dr. V. G. Lava, for his valuable criticisms and suggestions in the preparation of the paper.

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PHILIPPINE LYMNÆIDÆ AND PLANORBIDÆ

By J. C. BEQUAERT and W. J. CLENCH

Of the Museum of Comparative Zoölogy, Cambridge, Massachusetts

TWO PLATES

The late L. A. Faustino, in his Summary of the Fresh-water Mollusks of the Philippines (1928), listed under Lymnæidæ only *Amphipeplea cumingiana* Pfeiffer and *Planorbis philippinarum* Dunker. The *Planorbis* species should, however, be stricken from the list, since the name was merely a misspelling by Sowerby[1] of *Planorbis philippianus* Dunker,[2] from Cochabamba, Bolivia. In 1933 Faustino added to the list *Hippeutis umbilicalis* (Benson) and a new species, *Gyraulus prashadi.*

Previous to 1928, however, several other Lymnæidæ and Planorbidæ were recorded from the Philippines. Some of these snails are either known or potential intermediate hosts of worms pathogenic to man or domestic animals.

We have studied rather extensive material from the following sources: The Museum of Comparative Zoölogy, Cambridge, Massachusetts; the Philippine Bureau of Science (through Dr. E. Quisumbing); the School of Hygiene and Public Health of Manila (through Dr. Candido M. Africa); the Academy of Natural Sciences, Philadelphia; Dr. M. Tubangui; and Mr. P. de Mesa. Dr. F. Haas and Dr. A. Zilch have very kindly compared some of our specimens with von Möllendorff's types at the Senckenberg Museum, Frankfort a. M. Dr. Paul Bartsch has sent us paratypes of *Planorbis mindanensis* and *P. mearnsi*, and has given us information regarding the type of *Lymnæa imperialis* Lea.

In order to facilitate the study of these mollusks by local naturalists, we have included all original descriptions, many of which are not available in the Philippines, and we have figured all the species known to us.

LYMNÆIDÆ

Genus LYMNÆA Lamarck, 1799

Lymnæa is the original spelling of the name, which has also been written *Lymnus, Lymnula, Limneus, Lymnæus, Limnea, Limnæa, Limmæus,* and with other variant spellings.

---

[1] Conch. Icon. 20 (1877) pl. 3, figs. 23*a*, *b*.

[2] Proc. Zoöl. Soc. London (1848) 43.

The two species known from the Philippines belong to the subgenera *Galba* Schrank (1803) and *Radix* Denys de Montfort (1810).

LYMNÆA (GALBA) PHILIPPINENSIS Nevill. Plate 1, fig. 2.

Limnæa philippinensis NEVILL, Journ. Asiat. Soc. Bengal **50** pt. 2 (1881) 142 (Lucban, Luzon).

Limnæus philippinensis (Mousson) CLESSIN, Syst. Conch.-Cab. **1** pt. 17 (1886) 383, pl. 52, fig. 8 (Polillo, Luzon).

Limnæa philippinarum (Nevill) PAETEL, Cat. Conch.-Samml. **2** (1889) 399.

Limnæa (Fossaria) philippinensis v. MÖLLENDORFF, Bericht. Senckenberg. Naturf. Ges. (1893) 104 (Basay near Maasin, Leyte);[*] Nachrichtsbl. d. Mal. Ges. **30** (1898) 11 (Luzon; Leyte; Cebu).

Lymnæa philippinensis DE JESUS, Philip. Journ. Sci. **58** (1935) 302, pl. 1, figs. 1–6 (Luzon, Manila; Pampanga, Bulacan, Laguna, Tayabas, Batangas, Pangasinan, and Rizal Provinces. Samar. Leyte. Cebu. NEGROS, Occidental Negros Province).

LUZON, Laguna Province, Biñan; Maynit; Majayjay; Manila. BOHOL, Bohol Province, Barrio Toog, Vilar. LEYTE, Leyte Province, Santa Fé, Palo; Basay Maasin. CEBU, Cebu Province, Barili.

L. philippinensis is probably distributed throughout the Archipelago. Superficially it resembles the palæarctic *L. truncatula* (Müller) and is quite closely allied to *L. pervia* v. Martens, a widely distributed snail of China and Japan. As Nevill suggested, it is perhaps only a race of *L. pervia.* De Jesus (1935) has shown that it is, in the Philippine Islands, the intermediate host of the cattle liver fluke, *Fasciola hepatica* (Linnæus).

Original description:

> Shell scarcely rimate, small, horn coloured, conically globose, longitudinally striate under the lens; spire short, apex rather pointed; whorls four, the upper ones very small, scarcely convex, the last one very large in proportion, tumidly ventricose; aperture ovate, large, proportionately unusually broad, margins joined by a thin callosity, outer margin boldly, convexly rounded; columella straight, very slightly twisted, broadly reflected, rounded at base. Long. 8½, diam. 5½, apert. alt. 5¾, lat. 4 mil. This is a small species of the group of *Limnaea peregra*, closely allied to the next species (*L. andersoniana* Nevill), of which indeed some conchologists may prefer to rank it as a geographical variety. Both perhaps are geographical races, or subspecies, of *L. ollula* Gould, P. B. S. 1869 from Hongkong, sent me from that place and also from Swatow by Surgeon-Major Hungerford, which again = *L. pervia* Martens.—NEVILL, loc. cit.

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[*] Reference erroneously credited by de Jesus (1935) to Rehn.

LYMNÆA (RADIX) SWINHOEI var. QUADRASI v. Möllendorff. Plate 1, fig. 1.

Limnæa (*Radix*) *quadrasi* v. MÖLLENDORFF, Nachrichtsbl. d. mal. Ges. **30** (1898) 10 (Lake near Trinidad, Mountain Province, Luzon).

LUZON, Mountain Province, Trinidad Valley. We have also seen one of von Möllendorff's paratypes and have had some of our specimens compared with the holotype and paratypes at Frankfort.

The Philippines *L.* (*R.*) *quadrasi* is perhaps not really separable as a race or variety from typical *L. swinhoei* H. Adams.[4] Comparing Formosan with Philippine specimens, we find that in most typical *L.* (*R.*) *swinhoei* the aperture is more evenly semielliptical in outline, the lip joining the body whorl more at a right angle; while in *L.* (*R.*) *quadrasi* the outline of the the aperture is usually more ovate, with the lip obliquely inserted on the body whorl; but some of the Philippine snails scarcely differ in this respect from those of Formosa. Our largest *L.* (*R.*) *quadrasi* measures in length, 20 mm; greatest width, 12 mm; aperture, 14 by 8 mm.

L. swinhoei itself is, moreover, rather doubtfully distinct specifically from *L. plicatula* Benson, a common snail of China, which in turn is perhaps not more than a race of *L. auricularia* (Linnæus).

Original description:

T. rimata, ovato-acuminata, tenuis, pellucida, plicato-striata, in interstitiis subtilissime striatula, luteo-cornea. Spira brevis, acuta. Anfr. 4½, sat celeriter accrescentes, convexi, ultimus subinflatus, ¾ altitudinis aequans. Apert, parum obliqua, ovalis, peristoma rectum, acutum, basi subeffusum, columella paulum calloso-incrassata, intus spiraliter recedens. Diam. 10.5, alt. 16, apert. lat. 7, long. 11.5 mm.—MÖLLENDORFF, loc cit.

Genus MYXAS Sowerby, 1822

Limnea subg. *Myxas* (Leach) G. B. SOWERBY, Genera Fossil Recent Shells pt. 7 (1822); monotypic for "*Helix glutinosa* Mont. *Limnea glutinosa* Drap." = *Buccinum glutinosum* Müller, 1774.

Amphipeplea NILSSON, 1823, Hist. Moll. Sueciae (1822) 58. Monotypic for *Buccinum glutinosum* Müller, 1774.

Lutea GRAY in Turton, Man. Land Fresh-water Shells Brit. Isl. New ed. (1840) 243. Not of Brown, 1827.

Mixas (Leach) SAY, American Conchology (1832) pl. 31. A misspelling of *Myxas*. Same type.

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[4] Proc. Zoöl. Soc. London (1866) 319, pl. 33, fig. 13. Takow, Formosa.

Myxus (Leach) H. and A. ADAMS, Genera Recent Mollusca 2 (1855) 255 (as a synonym of *Amphipeplea*); emendation of *Myxas.* Same type.

Bullastra Bergh in Semper, Reisen Philippinen pt. 4 7 (1901) § 3 Lief. 1 254; monotypic for *Bullastra velutinoides* Bergh, 1901 = *Amphipeplea cumingiana* Pfeiffer, 1845.

Amphipeplia ANTON, Verzeichn. Conch. Samml. (1839) 50; misspelling of *Amphipeplea.* Same type.

Amphipeplaea AGASSIZ, Nomencl. Zoöl. Möll. (1846) 5; emendation of *Amphipeplea.* Same type.

Amphipepla SHERBORN, Index Animal. § 2 pt. 2 (1923) 277; misspelling of *Amphipeplea.* Same type.

MIXAS CUMINGIANA (Pfeiffer). Plate 1, fig. 3.

Amphipeplea cumingiana PFEIFFER, Proc. Zoöl. Soc. London (1845) 68 ("Naga, province of South Camarines," Luzon); KÜSTER, Syst. Conch.-Cab. 1 pt. 17*b* (1863) 59, pl. 10, figs. 18, 19; FAUSTINO, Summary Philippine Marine Fresh-water Mollusca (1928) 355.

Amphipeplea luconica BECK, Index Moll. (1837) 115 (Luzon; *nomen nudum*).

Lymnæa (*Amphipeplea*) *luzonica* SOULEYET, in Voyage de la Bonite Zoöl. 2 (1852) 525, atlas, pl. 29, figs. 33–37 (Manila, Pasig River).

Amphipeplea cumingi NEVILL, Hand List Moll. Indian Mus. 1 (1878) 239 (Luzon).

Amphipeplea quadrasi VON MÖLLENDORFF, Nachrichtsbl. d. malay. Ges. 27 (1895) 119 (in Manila, and Laguna and Pampanga provinces, Luzon; with var. *lamellifera* v. Möllendorff; loc cit., 119; Cebu and Leyte).

Bullastra velutinoides BERGH in Semper, Reisen Philippinen 7 pt. 4, § 3 Lief. 1 (1901) 254, pl. 20, figs. 22–34 (?Philippine Sea); FAUSTINO, Summary Philippine Marine Fresh-water Mollusca (1928) 347.

LUZON, Manila: Albay Province, Albay: Laguna Province, Calamba, San Juan River; Cabuyao, Barrio Dita; Nagcarlang, Palayan: Sorsogon Province, Donsol: Batangas Province, Lipa. MARINDUQUE, Santa Cruz. CEBU. BALABAC.

M. cumingiana appears to be distributed throughout the Archipelago.

Dr. A. Zilch, who compared some of our specimens with a paratype of *A. cumingiana* and with von Möllendorff's types of *A. quadrasi,* writes us that *A. quadrasi* is a synonym of *cumingiana* Pfeiffer. We had reached the same conclusion independently.

Küster (1863) gave *Limnæa imperialis* Lea[5] as a doubtful synonym of *A. cumingiana* Pfeiffer. The figure given somewhat resembles a *Myxas.* Fortunately Lea's type is at the U.

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[5] Trans. Amer. Phil. Soc. Philadelphia 5 (1834) 81, pl. 19, fig. 73. "South America"?

S. National Museum (No. 104910), where Doctor Bartsch examined it at our request. He writes us that it is "*Strophocheilus*, probably *ovatus*."

Original description of *A. cumingiana:*

Amph. testa ovato-globosa, tenuissima, longitudinaliter confertim striatula, nitidissima, pellucida, pallide cornea; spira brevissima, mucronulata, callo tenui semi-obtecta; columella nulla; margine anfractuum interno arcuato, appendice membranaceo (deciduo) munito; apertura amplissima, semi-ovali, margine supero breviter arcuato, patente. Long. 30, diam. 22 mill.; apertura 26 mill. longa.—PFEIFFER, loc. cit.

Original description of *L. luzonica:*

Lymnaea, testa ovata, tenui, fragilissima, pallide virescente; spira brevissima, retusa; anfractibus tribus; infimo maximo, convexo; apertura ovato-oblonga, basi angustata; labio inflexo, arcuato; labro acuto, fragilissimo. Coquille ovale trés-mince et très-fragile, translucide, d'un vert olivâtre pâle. Spire très-courte, aplatie, munie de trois tours dont le dernier forme á lui seul presque toute la coquille. Ouverture ovale-oblongue, rétrécie vers la base; bord interne infléchi et arqué; bord externe tranchant et d'une grande fragilité. . . . Dans les plus grands individus que nous avons recueillis, la coquille avait environ trois centimètres de longueur, et deux centimètres de largeur.

Original description of *A. quadrasi:*

T. subglobosa, tenuis, transverse plicato-striatula, nitens, pellucida, pallide lutescens; spira vix prominula apice mucronato. Anfractus 4 pone suturam profunde impressam obtuse angulati, ultimus superne planiusculus, tum obtuse angulatus, denique tumidus. Apertura parum obliqua, amplissima, peristoma rectum, acutum, margo superus ab insertione paulum ascendens et protractus, columellaris palum incrassatus, vix plicatus. Diam. 20, alt. 27, apert. diam. 16, alt. 23.5 mm.—Var. *lamellifera:* margine columellari fortiter lamellatim incrassato. Diam. 22.5, alt. 30 mm.'

—MÖLLENDORFF, loc. cit.

The original description of *B. velutinoides* is mostly based on the anatomy. The shell is described as follows: "Die wegen ihrer Cuticula gelbbraune, sehr dünne Schale hatte eine Länge von 18 bei einer Breite von fast 11 mm.; die von vorne nach hinten verlaufenden Furchen stark, die entblösst liegende Spira ziemlich gross.—BERGH, loc. cit.

PLANORBIDÆ

Genus PLANORBIS O. F. Müller, 1774

This genus is represented in the Philippines only by a South American species, recently introduced through the agency of man.

PLANORBIS (AUSTRALORBIS) LUGUBRIS Wagner. Plate 1, figs. 5 to 7.

Planorbis lugubris WAGNER in Spix, Test. Fluv. Brasil. (1827) 27, pl. 18, figs. 3–6 (Ilheos and Almada, Prov. Bahia, Brazil).

Planorbis albescens SPIX, Test. Fluv. Brasil. (1827) 27, pl. 28, fig. 5 (as a synonym of *P. lugubris*).

Planorbis nigricans SPIX, Test. Fluv. Brasil. (1827) 27, pl. 28, figs. 3, 4 (as a synonym of *P. lugubris*).

Planorbis viridis SPIX, Test. Fluv. Brasil. (1827) 27, pl. 28, fig. 6 (as a synonym of *P. lugubris*).

LUZON, Manila, in an aquarium (*P. de Mesa, 1936*): Batangas Province, Lipa, received from the School of Hygiene and Public Health, Manila.

We owe the identification of these snails as the South American *P. lugubris* to Dr. F. Haas and Dr. A. Zilch, which, on comparison of several lots of *lugubris* from Brazil, agree perfectly with the Philippine snails. All, however, are young shells, the largest seen measuring 12 mm in diameter.

Australorbis was recently proposed as a genus by Pilsbry[6] to replace *Planorbina* Dall, 1905 (*nec* Haldeman, 1843). We prefer to give it subgeneric rank under *Planorbis*.

Original description:

> Pl. testa discoidea, tenui, utrinque profunde umbilicata, ferruginea; anfractibus rotundatis, oblique striatis.—Testa discoidea, tenuis, pellucida, striis obliquis numerosissimis, subtilibus instructa; epidermide tenui vestita. Anfractus quatour rotundati, ultimus inflatus, cylindricus; caeteri gyri utrinque aream profunde excavatam formantes, quae tamen in parte inferiore est profundior quam in superiore. Apertura obliqua, margine acuto. Color epidermidis ferugineus; color testae epidermide privatae albus. Longitudo 3½ lin.; lat. 10½ lin.—WAGNER, loc. cit.

Genus ANISUS Studer, 1820

The Philippine species of this genus belong to the subgenus *Gyraulus* J. de Carpentier, 1837.

ANISUS (GYRAULUS) CONVEXIUSCULUS (Hutton). Plate 2, figs. 4 to 6.

Planorbis convexiusculus HUTTON, Journ. Asiatic Soc. Bengal pt. 2 18 (1849) 657 (Candahar; Quettah.; Kojuck Pass; Helmund River at Girishk; all foregoing localities in Afghanistan. Also from Tope Chancey Gangetic Provinces; and Pinjore below Simla); JUTTING, Treubia 13 (1931) 6, figs. 1–4.

Gyraulus convexiusculus ANNANDALE and PRASHAD, Rec. Indian Mus. 18 (1919) 52, figs. 7*b*, 8*b*; RENSCH, Arch. f. Hydrobiol. Suppl.-Bd. 13 (1934) 209.

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[6] Proc. Acad. Nat. Sci. Philadelphia 86 (1934) 55.

Planorbis compressus VON MARTENS, Malak. Blätter 14 (1867) 213 (Laguna de Bay, Luzon); MAX WEBER, Zoöl. Ergebn. Reise Niederl. Ost-Indien pt. 1 4 (1897) 13, pl. 1, figs. 17–22; pl. 12, figs. 7, 10 (Java; Celebes). Not of Michaud, 1831, nor of Hutton, 1834.

Planorbis neglectus VAN HASSELT, Algem. Konst en Letterbode (1823) 244 (Java; *nomen nudum*); CLESSIN, Syst. Conch.-Cab. pt. 17 1 (1884) 194, pl. 29, fig. 5 (Macassar; Yokohama).

Planorbis (*Gyraulus*) *demissus* WESTERLUND, Vega-Exped. Vet. Iakttag. 4 (1887) 204, pl. 4, fig. 16 (Pointe de Galle, Ceylon).

Planorbis infralineatus VON MARTENS, Malak. Blätter 14 (1867) 213 (Preanger-Regentschaften near Telaga-Patengan, Java).

Planorbis infracoloratus (von Martens) RENSCH, Arch. f. Hydrobiol. Suppl.-Bd. 13 (1934) 209 (as a synonym of *P. convexiusculus*; error for *infralineatus*.)

Planorbis (*Nautilina*) *javanicus* (Mousson) NEVILLE, Hand List Moll. Indian Mus. 1 (1878) 244 (Java; *nomen nudum*); GERMAIN, Rec. Indian Mus. pt. 3 21 (1923) 140 (as a synonym of *P. infralineatus*).

Planorbis propinquus (Mousson) VON MARTENS, Malak. Blätter 14 (1867) 214 (Buitenzorg, Java; as a synonym of *P. compressus*).

Planorbis sagoensis BULLEN, Proc. Mal. Soc. London pt. 3 7 (1906) 129, fig. (Mount Sago, Sumatra).

Planorbis compressus var. *siamensis* VON MARTENS, Malak. Blätter 14 (1867) 214 (Bangkok, Siam).

Planorbis confusus var. *tigrina* BAVAY and DAUTZENBERG, Journ. Conchyl. 58 (1910) 18 (Tonkin).

Planorbis compressus var. *striatus* BOLLINGER, Revue Suisse Zool. 22 (1914) 572 (Celebes).

Planorbis saigonensis CROSSE and FISCHER, Journ. Conchyl. 11 (1863) 362, pl. 13, fig. 7 (Saigon, Indo-China).

Planorbis saigonensis CLESSIN, Syst. Conch.-Cab. pt. 17 1 (1884) 191, pl. 29, fig. 3.

Planorbis (*Gyraulus*) *saigonensis* GERMAIN, Rec. Indian Mus. pt. 2 21 (1922) 119.

Gyraulus prashadi FAUSTINO, Philip. Journ. Sci. 51 (1933) 575, fig. 1 (San Antonio, Zambales Province, Luzon, type locality; also near Manila); DE JESUS, Philip. Journ. Sci. 58 (1935) 300 (Laguna, Bulacan, and Pampanga Provinces, Luzon).

Planorbis (*Gyraulus*) *mindanensis* BARTSCH, Proc. U. S. Nat. Mus. 32 (1907) 83, fig. 1 (Lake Buluan, Rio Grande Valley, Cotabato Province, Mindanao).

LUZON, Manila, Paco: Mountain Province, Trinidad Valley: Rizal Province, San Juan del Monte: Isabela Province: Ilocos Sur Province, Rio del Pueblo de Sinay. MINDANAO, Surigao Province. SIQUIJOR, Oriental Negros Province, Lazi. MARINDUQUE, Boac.

We have also seen paratypes of *G. prashadi* from San Antonio, Zambales Province, Luzon, and of *P. mindanensis* from Lake Buluan, Mindanao.

This appears to be the most common and most widely distributed of the planorbine snails in the Philippines. It is also known from Afghanistan, India, Siam, Indo-China, most of the East Indian Islands (with the exception of Borneo), as far east as Celebes and Buru; and is represented by slight variations in southern China (var. *chinensis* Dunker) and Japan (var. *japonicus* v. Martens).

There has been some divergence of opinion as to the proper name to be applied to this common snail. After careful study we agree with Annandale and Prashad (1919) in calling it *A. convexiusculus* (Hutton).

At the Museum of Comparative Zoölogy there are six specimens received from Benson as "*Planorbis convexiusculus*," which may have been part of the original lot described by Hutton. Some of these shells agree with Annandale and Prashad's figure in every particular, having the last whorl perfectly rounded; others, however, have the last whorl subcarinate. As Rensch (1934) has pointed out, the body whorl may be perfectly rounded off or more or less carinate, even in the same lot.

We have not been able to compare specimens of *P. euphraticus* Mousson, from Mesopotamia. We doubt, however, that *Planorbis compressus* Hutton,[7] based upon his *Planorbis* No. 12[8] from the Ganges River, India, not *P. compressus* Michaud, 1831, is specifically distinct from *A. convexiusculus*. No reliable differences can be pointed out from the description, and the species was based originally upon snails from the Ganges River (not northern India nor Quettah). Annandale and Prashad did not see Hutton's types.

We have carefully compared the type lot of *G. prashadi*, sent by the Philippine Bureau of Science, as well as paratypes of *P. mindanensis*, received from Doctor Bartsch, with various lots of *G. convexiusculus*, from India, Indo-China, and Java, and we are unable to separate the snails from the Philippines, either as a species or as a race. The figures of *prashadi* are rather misleading, as may be seen by comparing our photographs of the paratypes. *A. convexiusculus* is variable even in the same lot, particularly in the contour of the body whorl (which may be evenly rounded or more or less compressed) and in the shape of the aperture.

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[7] Journ. Asiatic Soc. Bengal 3 (1834) 93.

[8] Tom. cit. 91.

Original description of *P. convexiusculus:*

> Animal black or dusky. Shell depressed, ¼ of an inch in diameter; pale horn colour; polished; closely and obliquely striate; whorls 4 or 5; rounded; suture well defined; periphery subangular, but not influencing the aperture, which is ovato-lunate; umbilicus wide, discovering all the previous volutions; the whorls rising gradually and spirally from the horizontal, and rounded below.—HUTTON, loc. cit.

Original description of *P. saigonensis:*

> T. late, sed non profunde umbilicata, discoidea, tenuis, pellucida, cornea; vertice immerso; sutura profunda; anfr. 3 utrinque convexi, apertura fere horizontalis, ovato-rotunda; perist. acutum, marginibus callo tenui junctis.—Diam. maj. 4½, min. 4, alt. 1½ millim.—CROSSE and FISCHER, loc. cit.

Original description of *G. prashadi:*

> Shell discoidal, small, thin, somewhat flat, transparent or translucent, whorls five, rounded, closely and obliquely striated, periphery subangular, spire depressed, aperture egg-shaped. A few of the specimens are black due to habitat. Height, 1 mm.; maximum diameter, 5 mm. This species differs from *G. convexiusculus* (Hutton), which it closely resembles, in having more whorls; and in the shape of the mouth, which is more oviform. It differs from *G. euphraticus* Mousson in being more convex and in having the whorls more rounded, in having an egg-shaped aperture and in having the angle on the middle of the outer lip more pronounced but more like that of *G. convexiusculus.*—FAUSTINO, loc. cit.

Type at National Museum of Philippine Bureau of Science, Manila.

Original description of *P. mindanensis:*

> Shell lenticular, biconcave, thin, semitransparent, corneous. Upper surface decidedly more concave than the lower, showing all the whorls which increase evenly and rapidly in size. The entire upper surface is marked by numerous, quite prominent, irregularly developed lines of growth. Periphery of the last whorl marked by a slender keel. The basal parts of the whorls are a little more convex than the upper sides, with the incremental lines less strongly developed. The center of the base is only slightly depressed below the plane of the last whorl; in fact the most convex part of all of the whorls on the base falls almost in an even plane. The turns are separated above and below by well-impressed sutures. Aperture quite large, suboval, decidedly oblique, angulated at the middle of the outer lip by the slender keel. Columella practically absent; parietal wall covered with a thin callus. The type has four and one-fourth whorls and measures: Greater diameter, 6.7 mm.; lesser diameter, 5.7 mm.; altitude, 1.7 mm.—BARTSCH, loc. cit.

Type at United States National Museum.

ANISUS (GYRAULUS) QUADRASI (v. Möllendorff). Plate 2, figs. 7 to 9.

Planorbis (*Gyraulus*) *quadrasi* VON MÖLLENDORFF, Bericht. Senckenberg. Naturf. Ges. (1893) 105, pl. 3, figs. 11, 11*a–c* (Montalban, LUZON, type locality; Leyte); BARTSCH, Proc. U. S. Nat. Mus. 32 (1907) 83.

LUZON, Rizal Province, Montalban, paratypes (Philippine Bureau of Science), San Juan River. MINDORO, Mindoro Province, Naujan.

Some of the specimens from San Juan River were compared by Dr. F. Haas and Dr. A. Zilch with v. Möllendorff's types at the Senckenberg Museum, in Frankfort on the Main.

This species differs rather markedly from *A. convexiusculus* in the rapidly enlarged whorls and the number of whorls for the small size. In all specimens seen the last whorl is rounded, without any trace of carina.

Original description:

> T. discoidea, subcompressa, utrimque subaequaliter leviter impressa, tenuis, leviter arcuatim striatula, pallide virescenti-flavida, subnitens. Anfr. 3 rapide accrescentes, convexiusculi, sutura sat profunda discreti, ultimus ad peripheriam bene rotundatus. Apertura diagonalis, ovalis, sat excisa; peristoma simplex, acutum, intus callo latiusculo, albo, parallelo munitum.—Diam. maj. 3.5, alt. 1 mm.—Dieser kleine *Gyraulus* steht durch die geringe Zahl der Windungen und die Dimensionen dem *Pl. heudei* Cless. von Hong-kong, Süd-China und Hainan am nächsten, unterscheidet sich aber dadurch, dass die Schale oben und unten etwa gleichmässig vertieft ist, während bei *Pl. heudei* die Unterseite eine stärkere Aushöhlung zeigt. Auch hat die Peripherie keine Spur von Kante, und die Mündung ist weniger schief.—VON MÖLLENDORFF, loc cit.

Type at Senckenberg-Museum, Frankfort on the Main.

Genus HIPPEUTIS Charpentier, 1837

HIPPEUTIS UMBILICALIS (Benson). Plate 1, figs. 8 to 10; Plate 2, figs. 10 to 12.

Planorbis umbilicalis BENSON, Journ. Asiatic Soc. Bengal 5 (59) (1836) 741 (probably Sylhet, India).

Hippeutis umbilicalis FAUSTINO, Philip. Journ. Sci. 51 (1933) 577, fig. 2 (San Antonio, Zambales Province, Luzon; Sitio Napayacan, Buguey, Cagayan Province, Luzon).

Segmentina umbilicalis GERMAIN, Rec. Indian Mus. pt. 3 21 (1923) 176, pl. 2, figs. 19–21 (type from Sylhet).

Planorbis dorrianus WATTEBLED, Journ. Conchyl. 32 (1884) 126, pl. 6, fig. 2 (Long-Xuyen, Cochin-China).

Planorbis dorri (Wattebled) GERMAIN, Rec. Indian Mus. pt. 3 21 (1923) 178.

Planorbis (*Helicorbis*) *mearnsi* BARTSCH, Proc. U. S. Nat. Mus. 32 (1907) 84, fig. 2 (Lake Buluan, Rio Grande Valley, Cotabato Province, Mindanao).

LUZON, Cagayan Province, Buguey, Sitio Napayacan: Zambales Province, San Antonio. MINDANAO, Surigao Province. BOHOL, Bohol Province, Vilar, Lagunita del Sitio Mayapo.

We have also seen a paratype of *P. mearnsi* from Lake Buluan, Mindanao.

We have compared our Philippine lots with specimens of *umbilicalis* from Tonkin and can find no consistent or reliable difference, even of subspecific or racial value. We figure specimens from Tonkin, as well as a paratype of *mearnsi* from the Philippines. Germain claims that this species should be placed in *Segmentina;* he was unable to find the inner laminæ or barriers, characteristic of the genus, but surmises that they were resorbed. In the many specimens, of all ages, examined by us, there was never a trace of laminæ. We agree with Bavay and Dautzenberg[9] that *umbilicalis* is a *Hippeutis.*

Original description of *P. umbilicalis:*

Testa quasi dextra luteo-cornea, polita, leviter radiato-striata, infra excavato-depressa, anfractibus omnibus versus umbilicum profundum spectantibus, ultimo interiores pene tegente; supra convexa, versus apicem planata, apice concavo, omnibus anfractibus satis apparentibus: periphaeria obtuse angulata. Diam. 0.3 poll.—This shell belonging to the same division of *Planorbis* as the British species *Pl. fontanus* (*Pl. nitidus* Lamarck) in which the whorls on the inferior side are nearly covered by the succeeding ones, may easily be distinguished from that species, which it resembles also in colour, by the greater convexity of the last whorl towards the periphery, and by the slope towards the penultimate whorl, on the under side; while in *Pl. fontanus* the convexity is next to the penultimate whorl, and the slope tends toward the circumference. The disposition observed in *Pl. umbilicalis* occasions a great concavity on the under side of the shell. The superior margin of the aperture, as in most of the depressed Planorbes, projects much behind the inferior margin, occasioning a great obliquity from the plane of the axis. The North American species *Pl. deflexus* and *Pl. exacuens* of Say, more especially the latter, have an affinity to this shell, which is probably an inhabitant of the streams of silhet.—BENSON, loc. cit.

Original description of *P. mearnsi:*

Shell lenticular, vitreous, horn color. Whorls increasing regularly in size, the last enveloping the greater part of the previous turns. All of the whorls show evenly coiled on the dorsal surface in the extremely regularly conically depressed apex. The last half turn only, deviates from the regular spiral in having the summit gradually deflected until it falls about halfway between the summit and periphery on the preceding turn, at the aperture. The angle at the junction of the outer wall and the parietal wall is filled up for a short distance, and this shows through the

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[9] Journ. Conchyl. 58 (1910) 19.

shell as a moderately broad solid band, and makes the whorls appear as if they had a double suture. The whorls are evenly rounded on the dorsal surface and marked by moderately strong incremental lines only. Sutures lightly impressed. Periphery of the last whorl bluntly but strongly angulated. Base almost flat, with a moderately broad umbilicus, in which the whorls can be seen regularly and evenly coiled, but here also the last half of the last one becomes more and more openly coiled until it reaches a point at the aperture, about one-third of the distance toward the periphery from the umbilicus to the periphery. The base, like the upper surface, is marked by numerous incremental lines. Aperture decidedly oblique, arrow shaped, the apex falling at the periphery, and the two barbs above and below the periphery of the preceding turn. Outer lip thin, somewhat sinuous; basal lip almost straight; columella exceedingly short, represented by the mere upward turn of the basal lip; parietal wall covered by a thin callus. The type has almost five whorls and measures: Altitude 1.5 mm.; greater diameter, 5 mm.; lesser diameter, 4.4 mm. The only other *Helicorbis* reported from the islands is *P.* (*H.*) *luzonicus* Möllendorff. The much larger size—altitude, 3 mm.; greater diameter, 10.5 mm.; lesser diameter, 9 mm.—is sufficient to distinguish it from the present species.
—BARTSCH, loc. cit.

Type at United States National Museum.

HIPPEUTIS LUZONICUS (V. Möllendorff).

Planorbis (*Hippeutis*) *luzonicus* VON MÖLLENDORFF, Nachrichtsbl. d. Malay. Ges. 27 (1895) 120 (near Libmánan in Camarines Province, Luzon).

Planorbis (*Helicorbis*) *luzonicus* BARTSCH, Proc. U. S. Nat. Mus. 32 (1907) 84.

Original description:

T. late et aperte umbilicata, discoidea, solidula, subpellucida, sat distincte striatula, corneo-lutea; spira plana. Anfr. 5 lente accrescentes, sutura distincte marginata, profunda discreti, convexiusculi, ultimus basin versus sat acute angulatus, basi fere planus. Apertura diagonalis, lanceolata, peristoma rectum, acutum. Diam. maj. 10.5, min. 9; alt. 3 mm.
—V. MÖLLENDORFF, loc. cit.

Type at Senckenberg Museum, Frankfort on the Main.

The species is unknown to us.

Genus BULINUS O. F. Müller, 1774

For a recent discussion of this genus see Pilsbry and Bequaert [10] and F. Hass.[11] As pointed out by B. Prashad [12] the species of the Malayan Archipelago differ markedly from the African forms, placed in *Bulinus* proper (*Isidora* Ehrenberg), in being more elongate, with distinctly produced spire and a well-marked fold along much of the columella. They may be conveniently grouped in a distinct subgenus, *Physastra* Tapparone-Canefri.[13] The group is known from Sumatra, the Philippines, Celebes, Amboina, Timor, New Guinea, New Caledonia, and some of the other Pacific Islands, and Australia and New Zealand. Whether *Pulmobranchia* Pelseneer, based upon a species from Madagascar, is a synonym of *Physastra* (as Thiele states) is open to question.

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[10] Bull. Amer. Mus. Nat. Hist. 53 (1927) 132.

[11] Arch. f. Naturg., N. F. pt. 2 4 (1935) 230; Abh. Senckenberg. Naturf. Ges. Abh. 431 (1936) 26.

[12] Rec. Indian Mus. 22 (1921) 475.

Two species from the Philippines were referred to *Ameria* H. Adams.[14] This name should be applied to a subgenus of *Bulinus*, characterized by the low or somewhat depressed spire and the presence of a spiral carina or shoulder on the body whorl. Of the two Philippine species, *A. quadrasi* v. Möllendorff is said to have the whorls convex and subcanaliculate at the suture, and consequently appears to be a *Physastra*. *A. hidalgoi* Quadras and v. Möllendorff, described as having the whorls "rather sharply carinate above the middle," may be a true *Ameria*.

BULINUS (PHYSASTRA) HUNGERFORDIANUS (Nevill). Plate 1, fig. 4.

Physa hungerfordiana NEVILL, Journ. Asiat. Soc. Bengal pt. 2 50 (1881) 143 (Lucban, Luzon).

Physa semperi CLESSIN, Syst. Conch.-Cab. pt. 17 1 (1886) 348, pl. 49, fig. 6 (Mancayan, Philippines).

LUZON, Manila: Laguna Province, Laguna Bay, Santa Cruz; Calamba, San Juan River; Cabuyao: Rizal Province, Alabang River, Muntinglupa River; Antipolo. MINDANAO, Cotabato Province, Malabán. PANAY.

The species is probably widely distributed throughout the Archipelago. We have seen several lots provided by v. Möllendorff with two manuscript varietal names ("slightly ventrose," "convex"), but are unable to separate them from the typical form.

The many lots of *Bulinus* we have seen from the Philippines belong to this one species.

Original description of *Physa hungerfordiana:*

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[13] Ann. Mus. Civ. Stor. Nat. Geneva 19 (1883) 245; type: *Physastra vestita* Tapparone-Canefri, of New Guinea.

[14] Proc. Zoöl. Soc. London (1861) 143; type: *Physa (Ameria) carinata* H. Adams, of Australia.

Shell convexly ovate, imperforate, moderately thick, scarcely transparent, somewhat obsoletely striate, striæ close, regular, slightly flexuous; yellowish brown, generally covered with a dark coloured deposit; spire turretly produced, suture excavated, apex somewhat obtuse; whorls 3½, increasing rapidly, convexly swollen; aperture narrowly produced, as broad above as below, outer margin gradually rounded; columella somewhat reflected or thickened, twisted, bent a little backwards at base. Long. 13½ to 14½, diam. 7½; apert. alt. 8, lat. 4 mil. The only other Philippine, or indeed Malayan, species except *Ph. moluccensis* Lesson, is *Ph. philippina* Martens, Malak. Blät. 1867; long. 19, diam. 12 mil. Küster's Pl. I, figs. 18–20, will give a rough idea of the general shape of *Ph. hungerfordiana.* —NEVILL, loc. cit.

The present location of the type is unknown.

Original description of *Physa semperi:*

Testa elongato-ovata, levissime rimata, leviter striata, tenuis, fuscocornea; spira elongata, obtusa; anfr. 5, celeriter accrescentes, valde convexi, sutura profunda separati; ultimus parum elongatus, fere dimidiam partem longitudinis aequans; apertura anguste-ovata; peristoma acutum, tenue, marginibus callo columellari tenui conjunctis; columella tenuis, modice contorta. Lg. 16.5 mm.; diam. 7 mm. Gehäuse: verlängert-eiförmig, sehr fein geritzt, fein gestreift, dünnschalig, bräunlich-hornfarben; Gewinde verlängert, stumpf; Umgänge 5, rasch zunehmend, sehr gewölbt, durch tiefe Naht getrennt; der letzte etwas verlängert, fast die Hälfte der Gehäuselänge erreichend; Mündung schmal-eiförmig; Mundsaum dünn, scharf; Ränder durch sehr feine Spindelschwiele verbunden; Spindel dünn, weisslich, mässig gedreht, unten nach rechts gebogen.—CLESSIN, loc. cit.

The type is at the Berlin Museum.

BULINUS (PHYSASTRA) QUADRASI (v. Möllendorff).

Ameria quadrasi VON MÖLLENDORFF, Nachrichtsbl. d. mal. Ges. **27** (1895) 119 (Lake Mainit in Mindanao).

Original description:

T. sinistrorsa, vix rimata, oblonga, tenuis, subpellucida, leviter striatula, lineis spiralibus confertis undique decussata, pallide straminea, plerumque taeniis angustis, castaneis plus minusve numerosis picta. Anfr. 3½–4 (apice plerumque eroso) convexi, rapide accrescentes, sutura valde impressa, subcanaliculata disjuncti. Apert. parum obliqua, oblonge ovalis, superne et inferne acuminata, peristoma rectum, acutum, margine columellari paulum dilatato, callo sat lato apresso. Diam. 8.5, alt. 19.5, apert. diam. 4.5, long 12 mm.—v. MÖLLENDORFF, loc. cit.

Type at Senckenberg Museum, Frankfort a. M.

We have not seen this species, which, to judge from the description, may have been based on large specimens of *B. hungerfordianus.*

BULINUS (PHYSASTRA) PHILIPPINUS (v. Martens).

Physa philippina E. v. MARTENS, Malak. Blätter **14** (1867) 219 (Bosoboso *near* Manila, Luzon); CLESSIN, Syst. Conch.-Cab pt. **17** 1 (1886) 348, pl. 49, fig. 4.

Original description:

Testa elliptica, striata, fusca; anfr. vix 4, spiram brevem obtusam efficientes, infra suturam ventricosi, dein planiores; apertura subverticalis, ovata, basi levite effusa, margine externo superne sinuatim recedente; columella incrassata, spiratim torta, nitide alba, dentem simulante. Long. 19, diam. maj. 12, min. 9½, apert. long. 14, lat. 8 mill.—v. MARTENS, loc. cit.

Type at Berlin Museum.

According to Dr. A. Zilch (*in litt.*) the paratypes at the Senckenberg Museum, Frankfort on the Main, are quite distinct from our specimens of *B. hungerfordianus*. The spire is much more obtuse and the body whorl more swollen. The types were collected by v. Martens himself. It seems strange that later collectors have not found the species in the vicinity of Manila.

BULINUS (AMERIA) HIDALGOI (Quadras and v. Möllendorff).

Ameria hidalgoi QUADRAS and v. MÖLLENDORFF, Nachrichtsbl. d. malay. Ges. 27 (1895) 120 (Lake Mainit in Mindanao).

Original description:

T. sinistrorsa, imperforata, ovato-conica, solidula, transverse striatula et sulcis confertis spiralibus exarata, unicolor brunnea aut lutescenti-cornea taeniis latiusculis castaneis ornata. Anfr. 4 modice convexi, supra medium sat acute carinati, infra carinam spiraliter impressi. Apertura parum obliqua, supiriformis, peristoma rectum, acutum, columella valde calloso-incrassata, subtorta, intus superne subdentata. Diam. 5, alt. 9, apert. long. 5.5, lat. 3 mm.—QUADRAS and v. MÖLLENDORFF, loc. cit.

Type at Senckenberg Museum, Frankfort on the Main.

From the statement that the whorls are rather acutely carinate above the middle this snail appeals to be a true *Ameria*, not a *Bulinus*. Unfortunately we have not seen specimens.

ILLUSTRATIONS

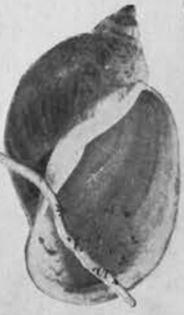
PLATE 1

FIG. 1. *Lymnæa* (*Radix*) *swinhoei* var. *quadrasi* v. Möllendorff; × 2.
2. *Lymnæa* (*Galba*) *philippinensis* Nevill; × 4.
3. *Myxas cumingiana* (Pfr.); × 1.
4. *Bulinus* (*Physastra*) *hungerfordianus* (Nevill); × 2.

FIGS. 5 to 7. *Planorbis* (*Australorbis*) *lugubris* Wagner; × 4.
8 to 10. *Hippeutis umbilicalis* (Benson); specimen from Tonkin; × 5.
11 to 13. *Planorbis* (*Gyraulus*) *mindanensis* Bartsch, paratypes; × 5.

PLATE 2

FIGS. 1 to 3. *Gyraulus prashadi* Faustino, paratypes; × 5.
4 to 6. *Anisus* (*Gyraulus*) *convexiusculus* (Hutton), specimen from India, possibly paratype; × 5.
7 to 9. *Anisus* (*Gyraulus*) *quadrasi* (von Möllendorff), paratypes; × 5.
10 to 12. *Planorbis* (*Helicorbis*) *mearnsi* Bartsch, paratype; × 5.



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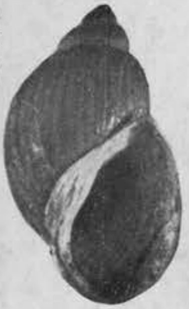

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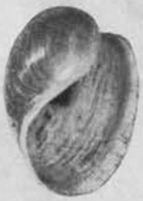

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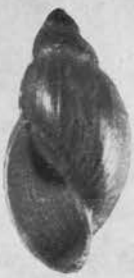

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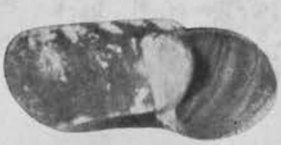

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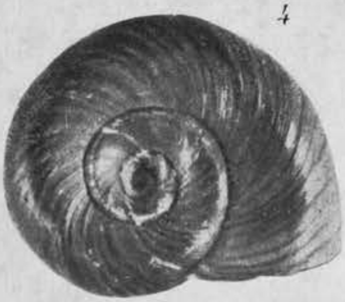

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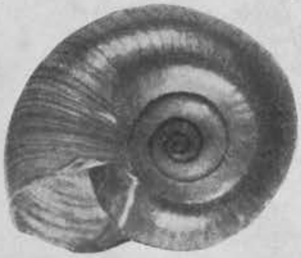

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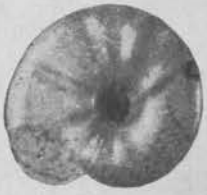

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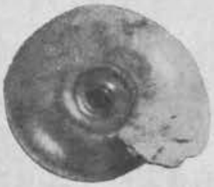

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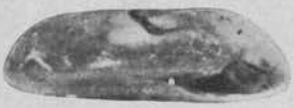

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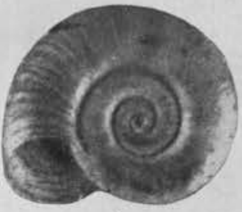

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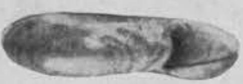

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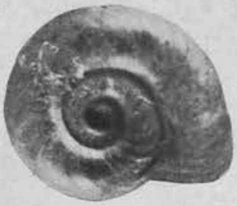

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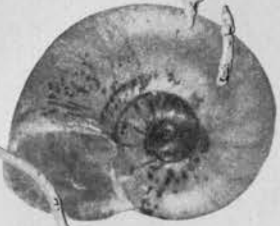
PLATE 1.



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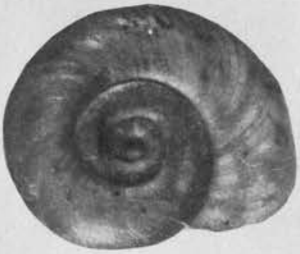

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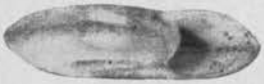

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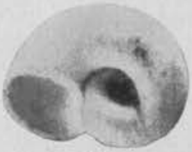

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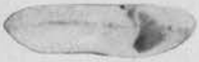

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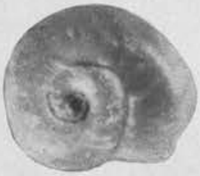

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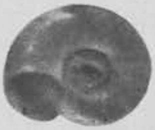

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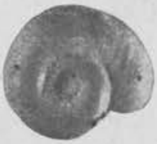

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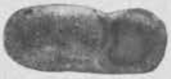

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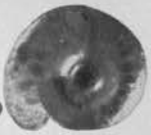

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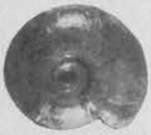

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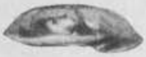

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PLATE 2.

ADDITIONS TO THE APHID FAUNA OF FORMOSA (HEMIPTERA), V[1]

By RYOICHI TAKAHASHI

Of the Department of Agriculture, Government Research Institute, Formosa

THREE TEXT FIGURES

MATSUMURAJA RUBIFOLIÆ Takahashi var. **TAIHEISANA** var. nov. Text fig. 1.

Wingless viviparous female.—Yellow. Head small, slightly convex at middle of front, with many granules on dorsum except on large median area, and with capitate setæ, of which four on posterior part are much shorter. Antennæ dusky on apices of segments three to five and on distal area of basal part of segment six, segment three without sensoria, with about ten minute setæ, very slightly striate; segments three to five somewhat constricted near the tip; relative lengths of segments about as follows: III—46, IV—35, V—37, VI—24+94. Rostrum reaching middle coxæ, distal segment twice as long as wide, nearly as long as penultimate, tapering, with three pairs of long setæ. Thorax and abdomen with granules on dorsum. Pronotum with a pair of capitate setæ near anterior margin and a similar, but a little longer, seta on each side; mesonotum with a pair of very short capitate setæ near hind margin and two similar longer setæ on each side; basal seven abdominal segments with a very short capitate seta on each side; abdominal segments four to six with a pair of capitate setæ at middle of dorsum; segment seven with four longer capitate setæ on dorsum; segmen eight with four very long simple setæ in a row on dorsum and a very short simple seta on each side; dorsal capitate setæ variable in length. Cornicles slightly dusky on tip, very slightly swollen near apex, roughly imbricated except on swollen part, as long as width of head including eyes, longer than antennal segment three. Cauda stout, pale. Tibiæ slender, slightly stouter than antennal segment three, with many setæ, of which those on lateral side are capitate and shorter than diameter of tibia; tarsi imbricated, with a median stiff seta and two

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[1] Part IV was published in the Philip. Journ. Sci. 63 (1937) 1–19.

much longer lateral setæ on basal segment in fore and middle pairs, but with only two long setæ on it in hind pair. Length of body, 1.7 millimeters; width of head including eyes, 0.32; length of antenna, 1.2; length of antennal segment three, 0.217, width at middle, 0.023; length of cornicle, 0.32; length of hind tibia, 0.65, width at middle, 0.028; length of hind tarsus, 0.097; dorsal seta on pronotum, 0.023 to 0.026; capitate seta on seventh abdominal tergite, 0.051 to 0.055; distance between cornicles, 0.37.

Host.—*Rubus* sp.

Habitat.—Shin-Taiheizan, altitude about 6,000 feet, Rato-gun, Taihoku Prefecture.

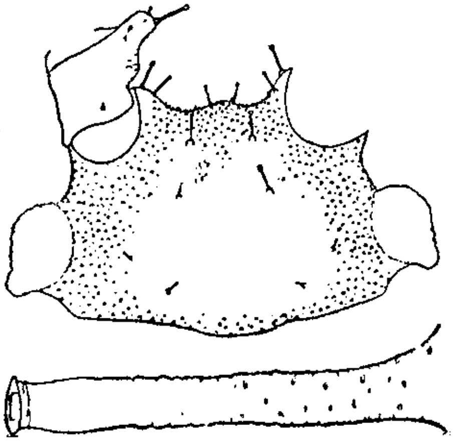

FIG. 1. *Matsumuraja rubifoliæ* Takahashi var. *taiheisana* var. nov.; wingless viviparous female. Head and cornicle.

Two specimens were taken by me October 14, 1937. The present variety differs from the typical form as follows: Dorsal capitate setæ on posterior part of head shorter. Tubercle on base antennal segment a little shorter. Thorax with fewer shorter setæ. Basal abdominal segments with shorter setæ on side and fewer shorter setæ on median area of dorsum. Dorsal setæ on abdominal segment eight simple, not capitate. In typical form meso- and metanotum and basal abdominal segments with four capitate setæ in a row on the median area of dorsum.

AULACORTHUM SOLANI Kaltenbach.

Acyrthosiphon pisi TAKAHASHI (part), Aphididæ of Formosa, VI. Dept. Agr. Res. Inst. Formosa Rept. 53 (1931) 63.

Host.—*Myrica rubra.*

Habitat.—Tattaka, Taichu Prefecture.

Some apterous forms were taken by me May 17, 1924, which agree well with the European specimens sent me by Dr. Hille Ris Lambers, though the dorsal setæ on the head are a little thinner in the Formosan material.

Acyrthosiphon pisi Kaltenbach was recorded by Dr. M. Maki from Formosa, but has not been collected by me in that island.

Most of the species recorded by me under the genus *Acyrthosiphon* Mordvilko must be included in the genus *Aulacorthum* Mordvilko, which differs from the former genus in possessing numerous granules on the head.

Aulacorthum kawanai Takahashi (syn. *Acyrthosiphon kuwanai* Takahashi) is closely allied to *A. solani* Kaltenbach, but is different from the latter in the longer dorsal setæ on the head, the darker cornicles, the distal segment of rostrum being about 2.7 times as long as wide, and in other characters. It attacks *Vitis* sp. and *Celtis formosana* in the mountainous regions of Formosa, and sometimes possesses three pairs of setæ on the cauda.

CEROSIPHA sp.

Wingless viviparous female.—Greenish yellow. Cornicles a little dusky on apex. Cauda pale. Antennæ and legs pale, slightly dusky on apices. Head a little convex on middle of front, with two pairs of moderate setæ between eyes, and a pair of slightly longer setæ between antennæ on dorsum, a curved seta on ental side of each frontal tubercle, and with a pair of long curved setæ on front, those between antennæ much shorter than antennal segment two. Frontal tubercles not developed, slightly convex on ental side. Eyes with ocular tubercles. Antennæ slender, imbricated, 5-segmented; segment three lacking sensoria, with about four small setæ which are blunt at tip and shorter than width of segment; relative lengths of segments about as follows: III—50, IV—22, V—27+60. Rostrum nearly reaching hind coxæ; distal segment a little more than twice as long as wide, a little tapering, blunt at apex, slightly longer than penultimate segment, with three pairs of long fine setæ. Prothorax and abdominal segments one and seven with a small lateral tubercle; tubercles on prothorax and abdominal segment one a little larger, longer than wide, tapering. Abdominal segment not corrugated, with a few curved dorsal setæ in a row, these setæ blunt apically and as long as those on head between antennæ. Cornicles cylindrical, a little broadened towards base, sometimes a little constricted near distal part, somewhat imbricated except on distal part, shorter than width of head, about three and one-half or four times as long as wide, a little shorter than antennal segment three, about twice as long as, or a little longer than, cauda. Cauda rather stout, not distinctly constricted, blunt at tip, distinctly longer than wide, with two pairs of curved lateral setæ. Legs slender; coxæ with about six very long fine curved setæ; trochanters with two similar setæ; tibiæ with many stiff setæ, some of which are as long as width of tibiæ; tarsi striate, with a median stiff seta and two lateral slightly or scarcely longer setæ on basal segment in fore and middle pairs. Length of body, about 1 millimeter; width of head including eyes, about 0.28; length of antenna, 0.78; width of antennal segment three at middle, 0.018; length of cornicle 0.18, width at tip, 0.032; length of hind tibia, 0.47, width at middle, 0.023; length of hind tarsus, 0.06; dorsal seta on head between antenna, 0.019 to 0.024.

Host.—A species of the Urticaceæ, on nether surface of young leaf.

Habitats.—Kayahara, Shinchiku Prefecture; Hatonosawa, near Taiheizan, Taihoku Prefecture.

A few apterous females were collected by me August 1, 1933, at Kayahara, and October 14, 1937, at Hatonosawa. New to the fauna of Formosa. This species may be hitherto undescribed, but I hesitate to give a new name to it, since the winged form is not known and comparison with other species of the genus and the related groups is not possible.

Genus CRANAPHIS novum

Winged viviparous female.—Body without prominent setæ. Head with a short conical tubercle on front above anterior ocellus. Frontal tubercles absent. Eyes with distinct ocular tubercles. Antennæ long, 6-segmented, lacking prominent setæ, with oval sensoria on segment three; distal part of last segment nearly as long as basal part. Rostrum very short. Cornicles very short, much wider than long. Cauda knobbed. Anal plate deeply bilobed, lobes parallel. Media on forewings twice branched, hind wings with media and cubitus present. Trochanters defined from femora; tibiæ with microtrichiæ and distal part and spines at tip; tarsi with some setæ on basal segment; empodial setæ flattened.

Genotype.—*Monellia formosana* Takahashi.

Differs from *Monellia* Oestlund in the shape of head, and from *Myzocallis* Passerini in the very short cornicles and in the presence of a conical tubercle on the front of head. In *Monellia* the head has no distinct median tubercle on the front.

CRANAPHIS FORMOSANUS Takahashi.

Myzocallis formosanus TAKAHASHI, Aphididæ of Formosa, III. Dept. Agr. Res. Inst. Formosa Rept. 10 (1924) 64; Proc. Ent. Soc. Washington 28 (1926) 160.

Monellia formosana TAKAHASHI, Trans. Nat. Hist. Soc. Formosa 19 (1929) 259; Aphididæ of Formosa, VI. Dept. Agr. Res. Inst. Formosa Rept. 53 (1931) 81.

Host.—*Arundinaria niitakayamensis.*

Habitats.—Arisan; Taiheizan, Taihoku Prefecture; Hassenzan, Taichu Prefecture; Hattsukan near Mount Niitaka (Mount Morrison).

Widely distributed on high mountains, occurring, however, in restricted numbers.

CERATOVACUNA ORIENTALIS Takahashi.

Oregma orientalis TAKAHASHI, Aphididæ of Formosa, II. Dept. Agr. Res. Inst. Formosa Rept. 4 (1923) 52, 144.

Ceratovacuna orientalis TAKAHASHI, Aphididæ of Formosa, VI. Dept. Agr. Res. Inst. Formosa Rept. 53 (1931) 95.

Winged viviparous female.—Horns on head long, slender, sharply pointed, as long as antennal segment two, a little divergent. Antennal segment three a little longer than segments four and five together, with thirty to thirty-three narrow sensoria in a row; segment four nearly as long as segment five, with thirteen sensoria; segment five with ten or eleven sensoria; relative lengths of segments about as follows: III—68, IV—27, V+29. Abdomen sclerotized on last two tergites. Cornicles small, not fringed with setæ, with a narrow sclerotized border at base. Fore and middle tarsi with a stout median seta and two much longer lateral setæ on basal segment; hind tarsi bearing only two very long fine setæ. Length of body, 2 millimeters; horn on head, 0.046; antenna, 0.68, width of antennal segment three, including sensoria, 0.046; diameter of cornicle at apex, including margin, 0.046; width of cauda, 0.088.

Host.—*Oplismenus* sp.

Habitat.—Piyahau, Suo-gun, Taihoku Prefecture.

A few winged forms, which have not been described hitherto, were taken by me October 16, 1937. This species is widely distributed in Formosa, and is characterized by the long horns on the front of head of the winged form.

CERATAPHIS BAMBUSIFOLIÆ Takahashi. Text fig. 2.

Cerataphis bambusifoliæ TAKAHASHI, Aphididæ of Formosa, IV. Dept. Agr. Res. Inst. Formosa Rept. 16 (1925) 50; VI, ibid. 53 (1931) 100; Lingnan Sci. Journ. 9 (1930) 11.

Winged viviparous female.—Head on dorsum with two pairs of small simple setæ on hind part, four similar setæ in a row anterior to dorsal ocelli, and two short setæ near each antennna.

Front with a pair of small thin spinelike setæ, which are much narrowed and flagellate on distal part, constricted at base, not reaching apex of front ocellus. Eyes large, with distinct ocular tubercles. Front ocellus protruding, as large in diameter as dorsal ocelli. Antennæ 5-segmented; segment one with about three simple fine setæ in a row near apex on ventral side; segment three slightly longer than segments four and five together, with a rather long seta, and twenty-six to thirty-four sensoria, which occupy much over half circumference of segment; segment four slightly narrowed towards base, slightly shorter than segment five, with nine to thirteen similar sensoria and a protruding primary sensorium at apex; segment five with ten to twelve sensoria and a rather small primary sensorium; relative lengths of segments about as follows: III—80, IV—35, V—40. Rostrum stout, not reaching middle coxæ, distal segment slightly longer than wide, smaller than penultimate segment, blunt apically. Abdomen with a few rather short simple setæ. Cornicles very short, on a circular sclerotized area, beset with four setæ. Cauda knobbed, knob much wider than long, slightly narrower than anal lobes, with about sixteen setæ. Anal plate bilobed but not separated, rather large, with about sixteen setæ on each lobe. Legs with some simple setæ; trochanters fused with femora; tibiæ narrower than antennal segment three, with setæ which are nearly as long as diameter of tibia; tarsi slightly striate, with four long fine capitate setæ at apex; fore and middle tarsi with a median stiff seta and two much longer lateral setæ on basal segment, hind tarsi bearing only two very long setæ. Wings somewhat infuscated along veins; first and second oblique veins on forewings united at bases, third obsolete on basal part, once branched; hind wings with two divergent oblique veins and two or three hooklets. Length of body, 2.0 millimeters; head including front ocellus, 0.248, width of head including eyes, about 0.53; length of antenna, 0.8; width of antennal segment three excluding sensoria, 0.035; diameter of cornicle at apex, 0.042; diameter of sclerotized area at base of cornicle, 0.085; width of cauda, 0.083; width of anal lobe, 0.09;

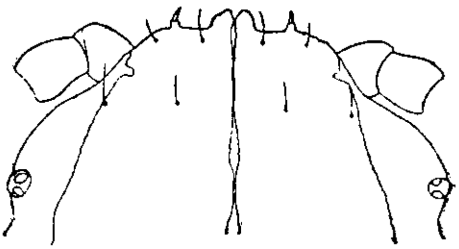

FIG. 2. *Cerataphis bambusifoliæ* Takahashi; grown nymph of winged form. Head.

length of hind tibia, 0.65; width of hind tibia at middle, 0.037; length of hind tarsus, 0.115.

Grown nymph of winged viviparous female.—Head sclerotized on dorsum except on lateral part and on a longitudinal median line, fused with pronotum, with a short blunt tubercle on front, which is divided on distal part. Front with a pair of small spines, each of which arises from a small tubercle; two pairs of smaller spines present on ventral side of head near front. Prothorax and abdominal segments with wax pores in a row on side.

Host.—*Arundinaria* sp.

Habitat.—Shin Taiheizan (altitude about 6,000 feet), Taihoku Prefecture.

Many winged forms and the nymphs were taken by me October 15, 1937. The winged form is unknown.

In *Cerataphis latanicæ* Boisduval the grown nymph of the winged form has a pair of short blunt tubercles on the front, each of which is provided with two spines at the tip.

THORACAPHIS MIRABILIS sp. nov.
Text fig. 3.

Wingless viviparous female.—Black, strongly sclerotized, with no wax. Body oval, prominently reticulate on dorsum of cephalothorax, somewhat corrugated and indistinctly somewhat reticulate on basal seven abdominal segments, which are fused together. Cephalothorax very large, with about twenty stout flattened setæ in a row along entire margin, which are equal in length, somewhat broadened towards apex, mostly curved and reaching far beyond margin of body; a pair of similar setæ present on median area between eyes; four pairs of minute blunt setæ on median area of thorax. Eyes submarginal, dorsal, con-

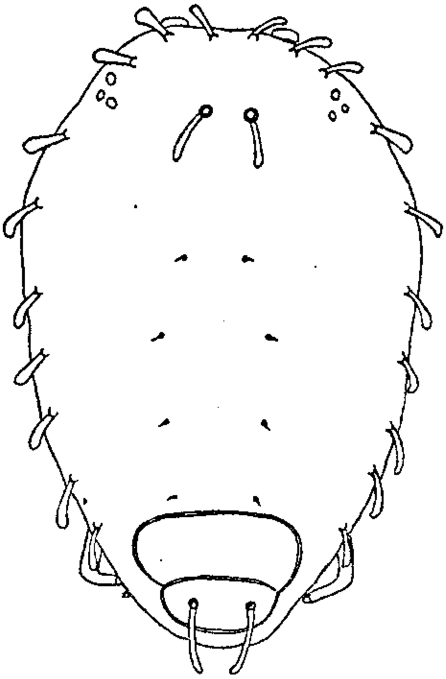

FIG. 3. *Thoracaphis mirabilis* sp. nov.; wingless viviparous female.

sisting of three facets. Antennæ small, not segmented, directed laterally, black, visible from above, with a subapical seta. Abdomen much reduced in size, separated from thorax, with no marginal rim; segment eight separated from basal part of abdomen, rounded on hind margin, with a pair of longer blunt setæ. Cornicles absent. Cauda knobbed, pale. Anal plate divided, lobes wider than long, pale. Genital plate rounded on hind margin, with about eight long setæ in a row on hind margin. Fore and middle legs concealed under body; hind legs exposed, black, not reaching hind end of body; hind tarsi short, not segmented, a little longer than wide, rounded apically, without claws. Length of body about 0.425 millimeter, width, 0.3; width of abdominal segment eight, 0.078; length of hind tibia, 0.046.

Host.—*Ficus* sp., on nether surface of leaf.

Habitat.—Dainano, Suo-gun, Taihoku Prefecture.

Many specimens cemented to the leaves were collected by me October 19, 1937.

Closely allied to *Thoracaphis fici* Takahashi, but differing in the smaller and narrower body and in the shorter flattened setæ along the body margin, as well as in the absence of wax on the body margin.

The materials upon which the present paper is based are deposited in the collection of the Department of Agriculture, Government Research Institute, Formosa.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. *Matsumuraja rubifoliæ* Takahashi var. *taiheisana* var. nov.; wingless viviparous female. Head and cornicle.

2. *Cerataphis bambusifoliæ* Takahashi; grown nymph of winged form. Head.

3. *Thoracaphis mirabilis* sp. nov.; wingless viviparous female.

PLANKTON STUDIES IN FORMOSAN INLAND WATERS[1]

By Masuzo Uéno

Of the Hydrobiological Station, Otsu (Shigoken), Japan

ONE PLATE AND ONE TEXT FIGURE

In recent years a great deal of work has been carried out on the plankton of Japanese inland waters, but these investigations were restricted chiefly to the middle and northern regions of the country. Little work has been done on the plankton of Taiwan (Formosa), whose inland waters, due to the subtropical climate of the island, are markedly different from those in the northern regions of Japan. The zoöplankton study of Zitugetu-tan (Lake Candidius by Harada(6) has been the only contribution hitherto published.[2]

A large series of plankton catches was made during three limnological expeditions to Taiwan, aided by research funds from the Hattori Hokokai: In April, 1935, undertaken by Dr. D. Miyadi; in July of the same year, by the present writer and Mr. K. Okugawa; and in January, 1937, by Doctor Miyadi. Of the material mentioned, four groups of animals have already been worked out,—the free-living Copepoda by Kikuchi (1936, in part) and Kiefer,(13, 14) the Cladocera and Rotatoria by Uéno.(31, 32) In the present paper are discussed the general ecological problems of the inland waters, with special reference to their plankton. A discussion of certain groups of plankton animals of zoögeographical interest has been published in another paper.(33)

I wish to express my cordial thanks to Dr. D. Miyadi for making it possible for me to undertake the expedition in July, 1935, and for helping me in various ways. My thanks are also due to Mr. K. Okugawa who assisted during the expedition; and to those who kindly identified various groups of organisms. For the financial aid granted by the Hatori Hokokai I offer my hearty thanks.

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[1] Contribution from the Otsu Hydrobiological Station of Kyoto Imperial University.

[2] Since the present article was written an extensive limnological and plankton study of Sango-tan was published by Harada.(7, 8) These papers are, however, only briefly referred to in footnotes of the present article.

The lakes and lakelets.—The inland waters studied may conveniently be divided into two different groups. The first group consists of those whose basins are relatively large in area and depth, and situated in the low plains or lower mountains. Zitugetu-tan[3] (Lake Candidius), Sango-tan, Kotohi Dam, Ryuran-tan, Rigyo-ti, and Toa-pi belong to this group. A number of lakelets and ponds on the northern part of the central mountain range as high as 2,300 to 2,600 meters above the sea belong to the second group. In the first expedition in April, 1935, four representative lakes, namely, Zitugetu-tan, Sango-tan, Rigyo-ti, and Toa-pi were investigated. A large irrigation dam, Kotohi, left unexplored in the preceding two expeditions, and these lakes, with the exception of Toa-pi, were again visited in January, 1937. In the second expedition in July, 1935, besides the three lakes, Zitugetu-tan, Sango-tan and Ryuran-tan, a number of high mountain lakelets were visited.

Methods.—In all the lakes except Kotohi dam, two sets of plankton catches were made with a small quantitative net of fine bolting silk, one set being hauled vertically at the deepest point of each lake from the bottom to the surface and the other horizontally. At Zitugetu-tan vertical hauls were made in both basins, Zittan and Gettan, in the same way as at the other lakes. In other localities, where no boat was available, the samples were secured with a small tow net or a hand net near the shore. The catches were counted in the Otsu Laboratory, two or three samples (usually 1 cc) being used from each catch. The results are presented according to their relative abundance in numbers calculated on a percentage basis.

Some physical and chemical determinations were made in the field. Transparency was determined with a Secchi white disc 25 cm in diameter. The determination of temperature and the hydrogen-ion concentration of the water was made in every case, and in the larger lakes equipped with a boat the vertical series of the dissolved oxygen content and of the alkalinities were also determined. Dissolved oxygen was determined by the usual Winkler's method; the alkalinity was determined by titration with n/10 hydrochloric acid for 100 cc of water, methyl-orange being used as indicator.(25) The hydrogen-ion concentration was determined colorimetrically by means of Clark-Lubbs' standard buffer solutions. The oxygen saturation was calculated on the basis of Fox's table. The oxygen data obtained by Miyadi are also cited in the present paper in unchanged form, though his data are represented in mg per liter of water.

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[3] "Tan" is the Formosan word for "lake."

ACCOUNT OF THE PLANKTON

ZITUGETU-TAN (LAKE CANDIDIUS)

Zitugetu-tan is the largest natural lake in Taiwan. Its maximum depth was only 5 meters(6) until 1934, when it was dammed as a reservoir for hydroelectricity and filled with water from a mountain stream. At present its maximum depth is about 18 meters.

The lake consists of two parts, an eastern larger basin called Zittan and a western smaller basin called Gettan, the former being deeper than the latter. The surface area is 7.74 square kilometers, but varies with the great variations in the water level. The altitude of the lake surface is about 740 meters above sea level.

The physical and chemical results obtained at three visits are shown in Table 1.

In spite of its high altitude the deep water of this lake is remarkably warm in summer, being above 20° C. in the middle of July, though the surface water is not so markedly warm. The thermocline does not develop distinctly. The dissolved oxygen content decreases greatly in the deep water in summer.

Since the lake has begun to receive the water of the mountain stream, Dakusui-kei, the chemical composition of its water has changed remarkably, the salt content having become from four to five times that before 1934. It will be clear from the results of chemical analysis of the water hitherto analysed (Table 2) that the calcium, magnesium, sulphate, and carbonate contents have also remarkably increased.(37) These salts, consisting chiefly of carbonate or sulphate of lime, have been brought into the lake by the Dakusui-kei, which drains through clay slates in its basin and dissolves out a large amount of the salts.

TABLE 1.—*Physical and chemical characteristics of Zitugetu-tan (Lake Candidus).*

ZITTAN BASIN.

Depth.	April 19, 1935, Miyadi.				July 14, 1935, Uéno.					January 1, 1937, Miyadi.			
	Temperature.	pH.	Oxygen.		Temperature.	pH.	Oxygen.		Alkalinity.	Temperature.	pH.	Oxygen.	
m.	°*C.*		*mg/l.*	*Per cent.*	°*C.*		*cc/l.*	*Per cent.*	*cc:100.*	°*C.*		*mg/l.*	*Per cent.*
0	23.9	8.3	8.54	89	27.8	8.0	4.82	79	1.28	19.8	7.7	7.74	75
1					27.4	8.0							
2	23.7	8.0	8.68	90						19.7	7.6	7.61	74
3					27.4	8.0							
4	22.1	8.0	10.06	108	27.0	7.8				19.7	7.6	7.45	72
5					25.0	7.6	6.15	96	1.40				
6	20.0	7.8	10.08	105						19.7	7.6	7.46	72
10	18.7	7.7	9.70	92	23.2	7.4	4.70	71	1.52	19.1	7.5	8.02	76
11										19.0	7.4	7.41	71
13					21.8		1.18	18	1.50				
14	18.2	7.3	6.70	63									
15					21.5	6.9	0.16	2	1.50				
16	18.0	7.1	4.82	46	20.2		0	0	1.76				
16.5	18.0	7.1	4.14	39									
	Transparency 3.5 m.				Transparency 5 m.					Transparency 3.2 m.			

GETTAN BASIN.

0	22.8	8.1	7.47	76	29.3	8.0	5.05	86	1.32	19.5		6.98	67
1					28.1	7.95							
2	22.7	8.1	7.16	73									
4	22.0	7.9	8.69	87									
5	20.4	7.9	10.22	99	25.6	7.8	5.68	87	1.46	19.5		6.75	65
7										19.5		6.91	66
8	19.4	7.7	9.01	87		7.6							
10	19.0	7.7	9.51	91	23.7	7.4	4.46	69	1.50				
13					21.8	7.0	0.35	5	1.56				
14	18.3	7.2	5.08	47									
14.3					21.7	6.85	0	0	1.66				
14.5	18.2	7.2	4.33	41									
	Transparency 3.7 m.				Transparency 5 m.					Transparency 2.4 m.			

TABLE 2.—*Chemical analysis of the waters of Zitugetu-tan.*[a]

Year.	Depth.	pH.	Total solids.	Na.	Ca.	Mg.	SO_4.	CO_2.	SiO_2.	P.	N.
	m.										
1919	0	----------	59.0	11.3	2.2	1.1	12.2	27.2	5.9	----------	----------
1933	0	----------	45.3	2.9	1.1	3.1	1.1	11.3	3.9	0.012	0.15
1935	0	8.3	206.4	11.3	44.3	20.1	41.5	55.6	8.9	0	0.19
	15	7.2	215.6	8.7	50.5	15.8	60.8	55.8	9.1	0	0.24

[a] Figures represent mg. per liter of water.

Owing to this marked change in the chemical composition of the water, there is a rather remarkable change in the composition of the plankton. Harada (6) has listed more than 30 species of zoöplanktons, 10 of copepods, 7 of cladocerans, 9 of rotatorians, and several of protozoans, nematodes, and insect larvæ (Diptera, Chaoborinæ), though his list contained several littoral species. In the material obtained on our three expeditions, however, the number of species of plankton animals remarkably decreased, and at the same time several hitherto unrecorded forms appeared.

The species of plankton animals and their relative numerical abundance at three different seasons are given in Table 3.

Zoöplankton.—As will be seen from the list, the present plankton fauna of the lake is composed chiefly of Copepoda, among which *Mongolodiaptomus formosanus* is the dominant species in both basins of the lake, and in every season comprises more than 30 per cent of the total plankton, often attaining 60 per cent (in April). This calanoid was recorded by Harada (6) under the name of *Diaptomus Birulai* Rylov, but, according to Kiefer, (13) the Candidius form is a new species and is to be placed under his genus *Mongolodiaptomus.* The 9 species of Cyclopoida recorded by Harada, with the exception of *Mesocyclops leuckarti,* were not found on our three expeditions. It is to be noted that there was found a recent immigrant of Cladocera; namely, *Ceriodaphnia rigaudi,* which, although the most common ceriodaphnid in Formosan inland waters, (31) was formerly not found in this lake. This warmth-tolerant form as well

TABLE 3.—*Composition of plankton of Zitugetu-tan.*[a]

Species.	April, 1935.		July, 1935.		January, 1937.	
	Z.	G.	Z.	G.	Z.	G.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Rotatoria:						
Brachionus calyciflorus	-------	-------	0.2	-------	-------	-------
Brachionus forficula[b]	-------	-------	-------	-------	-------	7.4
Schizocerca diversicornis[b]	-------	-------	0.9	0.3	-------	-------
Keratella valga tropica[b]	-------	-------	-------	-------	-------	0.2
Filinia longiseta[b]	12.5	63.0	-------	-------	-------	-------
Tetramastix opoliensis brevispina	-------	-------	-------	-------	0.3	0.8
Pedalion mirum[b]	0.1	0.1	-------	0.9	9.7	1.0
Pompholyx complanata	-------	-------	-------	-------	0.3	0.8
Cladocera:						
Diaphanosoma brachyurum[b]	14.0	8.0	2.6	6.5	2.0	-------
Ceriodaphnia rigaudi	4.0	1.9	10.1	15.3	8.9	19.8
Bosmina longirostris[b]	0.6	1.0	9.0	7.4	16.4	9.5
Alona rectangula	0.6	-------	-------	-------	-------	-------
Copepoda:						
Mongolodiaptomus formasanus[b]	59.6	17.6	33.9	41.0	34.7	30.4
Mesocyclops leuckarti[b]	-------	1.9	33.4	21.5	16.7	14.4
Nauplii[b]	8.5	6.5	9.9	7.1	11.0	15.7
	100.0	100.0	100.0	100.0	100.0	100.0

[a] Z and G represent the Zittan basin and Gettan basin, respectively.
[b] Found also in Harada's list.

as two other common cladocerans, *Diaphanosoma brachyurum* and *Bosmina longirostris,* seem to appear in the lake throughout the year. Several littoral cladocerans recorded by Harada (6) are not represented in our material, except *Alona rectangula.* It is probable that this is chiefly due to the immersion of the swamplike marginal regions of the Gettan basin due to the raised water level of the power dam. Of the rotatorians, *Pompholyx complanata, Tetramastix opoliensis brevispina,* and *Brachionus calyciflorus* are new members of the lake.

Phytoplankton.—The phytoplankton appeared to be very scarce, a very slight development of *Microcystis* water bloom being seen in April and July.

Bottom deposits.—The floor of the lake is extensively covered with a gelatinous mass of a blue-green alga, probably *Aphanotheca,* and also "Feindetritusgyttja" (18) rather rich in diatoms. This algal deposit peculiar to this lake is regarded as "Bodenalgenäwja." (22) Shibuya et al. (26) obtained the carbonitrogen ratio 5.90 : 8.67 for the bottom deposit of this lake.

Owing to the great change in the water level, a marked variation has occurred in the fauna and flora of the lake, as shown in the composition of the plankton stated above. Nine species of flowering aquatic phanerogams ever growing in this lake (16) are not found at present. This is one of the important reasons for the disappearance of littoral forms in the plankton catches. The midge larva of the subfamily Chaoborinæ (Corethrinæ) which was observed by Harada as a plankton in this lake was quite absent in our studies, not only in the plankton catches but also in many bottom-mud samples taken up by an Ekman-Birge botton sampler.

Zitugetu-tan is regarded at present as a gypsotrophic phase of the eutrophic type of lake, as will be discussed in a later chapter. However, vegetable substances such as tannin, humus, and the like, which were extracted from the sunken forest around the lake due to the rise of the water level (Plate 1, fig. 1), may have a marked modifying effect upon the water as well as the plankton fauna and flora of the lake. The effect of the sunken forest in changing a lake type was pointed out recently by Thienemann (28) in connection with several lakes of the low plains in northern Germany, where the rise of the underground water level has had a remarkable effect upon the marginal forest of those lakes.

SANGO-TAN (UZANTO DAM)

Among the artificial lakes in Taiwan, Sango-tan is the largest and deepest. It lies north of the city of Tainan and was constructed to irrigate the rice fields in the vicinity of that city. Its surface area is 10.10 square kilometers; the maximum depth is 31 meters at full water; the altitude of the lake surface is 58.2 meters.

The physical and chemical data obtained during three expeditions are given in Table 4.(7, 8)

The deep-water temperature is above 25°C. in July and exceeds 20°C. even in January. The formation of the thermocline is not distinct. The dissolved oxygen greatly diminishes even in April, being entirely absent below 18 meters. In July, 1935, however, there was observed a remarkable "complex stratification" (35) which may probably be due to the introduction of a large volume of cold water from the stream Sôbun-kei. The origin of the alkaline water of this lake is similar to that of Zitugetu-tan.

Zoöplankton.—The composition of the plankton does not differ essentially from that of Zitugetu-tan as stated above; the copepods are similarly the most important component and oc-

TABLE 4.—*Physical and chemical characteristics of Sango-tan.*

Depth.	April 17, 1935, Miyadi.				July 12, 1935, Uéno.					January 3, 1937, Miyadi.			
	Temperature.	pH.	Oxygen.		Temperature.	pH.	Oxygen.		Alkalinity.	• Temperature.	pH.	Oxygen.	
m.	°*C.*		*mg/l.*	*Per cent.*	°*C.*		*cc/l.*	*Per cent.*	*cc:100.*	°*C.*		*mg/l.*	*Per cent.*
0	29.7	8.4	8.85	107	30.6	9.0	6.64	126	1.24	20.2	7.8	7.44	83
1	------	------	------	------	30.7	9.0	------	------	1.26	------	------	------	------
2	26.9	8.4	10.29	123	29.8	8.8	------	------	------	20.2	7.8	7.83	------
3	------	------	------	------	28.4	7.6	3.12	57	1.20	------	------	------	------
4	21.5	7.9	6.16	71	------	------	------	------	------	20.1	7.8	7.78	------
5	------	------	------	------	27.5	7.4	2.22	40	1.54	------	------	------	------
6	22.5	7.5	2.22	25	------	------	------	------	------	20.1	7.8	7.84	------
8	21.2	7.4	2.00	22	------	------	------	------	------	20.0	7.8	6.68	------
10	20.4	7.4	1.59	17	26.4	7.4	3.36	59	1.44	20.0	7.8	7.96	85
12	20.0	7.4	0	0	------	------	------	------	------	20.0	7.85	7.75	------
14	19.8	7.4	0	------	------	------	------	------	------	20.0	7.85	7.78	------
16	19.7	7.4	0	------	------	------	------	------	------	19.8 (16.5 m.)	7.8	7.97	85
18	19.7	7.4	0	------	------	------	------	------	------	------	------	------	------
20	------	------	------	------	25.7	7.5	4.21	73	1.40	------	------	------	------
25	------	------	------	------	25.6	7.5	3.28	56	1.30	------	------	------	------
26	------	------	------	------	25.5	7.4	2.70	47	1.40	------	------	------	------
	Transparency 2.1 m.				Transparency 0.5 m.					Transparency 1.2 m.			

cupy more than 50 per cent of the total plankton. In Sango-tan, however, differing from Zitugetu-tan, *Mongolodiaptomus formosanus* is inferior to the three species of Cyclopoida, namely, *Mesocyclops leuckarti, Thermocyclops hyalinus,* and *T. taihokuensis.* The Cladocera fauna is characterized by the occurrence of a tropical element, *Diaphanosoma paucispinosum,* which originated in the Sunda region and does not occur in Zitugetu-tan. It is of interest ecologically that two different species of *Diaphanosoma,* one the northern *D. brachyurum* and the other the southern *D. paucispinosum,* mentioned above, coëxist in this lake. This may be explained in part, as the writer stated in another place,(31) by the fact that the water temperature of the lake is not too warm for *D. brachyurum* and not too cold for *D. paucispinosum.*

TABLE 5.—*Composition of the plankton of Sango-tan.*[a]

Species.	April, 1935.	July, 1935.	January, 1937.
	Per cent.	*Per cent.*	*Per cent.*
Rotatoria:			
Trichocerca capucina	----	----	1.4
Brachionus calyciflorus	0.3	21.8	7.8
Brachionus forficula	2.4	0.3	2.0
Schizocerca diversicornis	1.5	4.6	1.0
Keratella valga tropica	1.8	0.3	2.7
Asplanchna priodonta	3.2	2.6	----
Tetramastix opoliensis brevispina	----	0.3	0.3
Pedalion mirum	----	----	0.3
Pompholyx complanata	0.3	----	----
Cladocera:			
Diaphanosoma paucispinosum	5.9	9.0	6.8
Diaphanosoma brachyurum	2.0	3.0	2.0
Ceriodaphnia rigaudi	7.7	2.5	0.3
Bosmina longirostris	----	----	1.7
Copepoda:			
Mongolodiaptomus formosanus	13.3	9.5	15.6
Cyclops spp.[b]	52.0	36.3	31.9
Nauplii	9.6	9.9	26.2
Insecta:			
Chaoborinæ larvæ	----	0.3	----
	100.0	100.0	100.0

[a] Besides the species listed in this table, Harada (8) recorded the following ten forms: *Peridinium* sp., *Polyarthra platyptera, Diurella stylata, Dinocharis intermedia, Monostyla* sp., *Keratella cochlearis, Mesocyclops thermocyclopoides, Eucyclops prasinus candidiusi, Ergasilus japonicus,* and a free-living nematode. Three species appearing in the present table; namely, *Bosmina longirostris, Mesocyclops leuckarti,* and *Thermocyclops hyalinus,* are not recorded by Harada.(8)

[b] *Mesocyclops leuckarti, Thermocyclops hyalinus,* and *T. taihokuensis.*

Phytoplankton.—The phytoplankton appeared to be extremely scarce, being limited to a small number of *Ceratium hirundinella* (O. F. Müller) found in the July collection.

Bottom deposits.—The bottom deposit from a depth of 18 meters consists chiefly of "Feindetritusgyttja" containing a large amount of fine sand. No diatoms were found.

KOTOHI DAM

This irrigation dam is situated some 3 kilometers east of the town of Sinka, north of Tainan. Its surface area is 0.24 square kilometer; the maximum depth is about 12 meters; the altitude of the lake surface is 40 meters above sea level. This reservoir was visited only once by Miyadi, January 4, 1937. As there was no boat on the lake, only a littoral collection was made. The temperature of water near the shore was 20.3°C. (at 11 A. M.) and the pH of the water was 7.9; the water was remarkably turbid.

Plankton was very scarce, being composed chiefly of copepodean nauplii, no phytoplankton being found at all.

TABLE 6.—*Composition of plankton of Kotohi, January, 1937.*

	Per cent.
Polyarthra trigla	4.6
Brachionus calyciflorus	19.0
Brachionus forficula	4.0
Keratella cochlearis tecta	3.1
Keratella valga tropica	3.4
Schizocerca diversicornis	17.2
Scapholeberis mucronata	0.3
Bosmina longirostris	0.6
Alona intermedia	0.6
Mongolodiaptomus formosanus	2.1
Thermocyclops taihokuensis	12.3
Nauplii of Copepoda	32.8
	100.0

RYURAN-TAN

Ryuran-tan is a small lake occupying a shallow basin some 2.5 kilometers south of the town of Kôsyun that lies almost in the southern end of the island of Taiwan. The depression in which the lake lies is said to have been covered formerly by the sea. Therefore the lake may be regarded as a marine relic. The altitude of the lake surface is about 14 meters. The lake is fed by a spring which wells up to the west of the lake and discharges in the north. The surface area of this lake is about 0.97 kilometer; the greatest length being about 2 kilometers and the greatest breadth 0.7 kilometer. Miyadi(20) obtained a maximum depth of only 1 meter, January 6, 1937, while during my visit July 9, 1935, at which time the water level was observed to rise, the deepest point of 1.5 meters was obtained. In both visits the water was remarkably turbid and yellow-opaque.

The physical and chemical observations made in two visits are recorded in Table 7.

TABLE 7.—*Physical and chemical characteristics of Ryuran-tan.*

Depth.	July 9, 1935, Uéno.					January 6, 1937, Miyadi.			
	Temperature.	pH.	Oxygen.		Alkalinity.	Temperature.	pH.	Oxygen.	
m.	*°C.*		*cc./l.*	*Per cent.*	*cc./100.*	*°C.*		*mg/l.*	*Per cent.*
0	23.8	7.4	4.77	87	1.20	21.8	8.0	8.13	90
0.5	-----	-----	-----	-----	-----	21.8	8.0	9.32	100
1	23.7	7.6	4.74	87	1.52	21.8	8.0	7.79	86
1.5	23.5	7.4	3.67	67	1.40	-----	-----	-----	-----
	Transparency 10 cm.					Transparency 25 cm.			

Plankton.—The plankton and its relative abundance are summarized in Table 8.

TABLE 8.—*Composition of plankton of Ryuran-tan.*

Species.	July 9, 1935.	January 6, 1937.
	Per cent.	*Per cent.*
Rotatoria:		
Trichocerca capucina	-----	9.3
Brachionus angularis	-----	4.6
Brachionus forficula laevis	0.3	-----
Brachionus angularis caudatus	-----	0.1
Keratella cochlearis tecta	-----	0.1
Keratella valga tropica	0.3	1.8
Schizocerca diversicornis	-----	0.1
Filinia longiseta	0.3	1.5
Polyarthra trigla	-----	0.3
Pedalion mirum	-----	1.8
Pompholyx complanata	-----	31.5
Noteus militaris	0.6	-----
Monostyla bulla	0.3	-----
Cladocera:		
Diaphanosoma paucispinosum	5.6	1.6
Alona diaphana	0.3	-----
Copepoda:		
?*Mongolodiaptomus uénoi*	61.8	11.0
Cyclops sp. (young)	15.3	1.6
Nauplii	14.0	34.7
Decapoda: Zoëa	0.9	-----
Oligochæta: Naididæ	0.3	-----
	100.0	100.0

In July the plankton, though comparatively abundant, is restricted qualitatively, being represented chiefly by Copepoda.

No phytoplankton was found. In January the zoöplankton consists of a large variety of animals, especially rotatorians, of which *Pompholyx complanata* is the most abundant, representing more than 30 per cent of the total plankton. Among the three species of the genus *Brachionus*, *B. angularis caudatus* is the most noticeable. This form has never occurred in any other lake in Taiwan.(32)

Ryuran-tan is the most productive of zoöplankton of any of the lakes studied in Taiwan. This is true particularly with regard to the bottom fauna of this lake, which is exceptionally productive especially of mollusks in the Formosan lakes.(20)

RIGYO-TI

Rigyo-ti, though a small lake having a surface area of only 1.03 square kilometers, is the largest natural lake on the east coast of Taiwan Island. It lies in a closed basin between the streams Mokkui-kei and Rô-kei, some 10 kilometers southwest of the town of Karenko, and it is thought that the lake owes its existence to a large alluvial fan damming up the northern end of the basin. The lake was first sounded by Miyadi,(19) who obtained a maximum depth of 9 meters in the middle of the east side; in January, 1937, however, he failed to find a point deeper than 7.5 meters.(20) There has been slight change in the water level.

The physical and chemical results are shown in Table 9.

TABLE 9.—*Physical and chemical characteristics of Rigyo-ti, D. Miyadi.*

Depth.	April 11, 1935.				January 10, 1937.			
	Temperature.	pH.	Oxygen.		Temperature.	pH.	Oxygen.	
m.	°*C.*		*mg/l.*	*Per cent.*	°*C.*		*mg/l.*	*Per cent.*
0	22.0	8.4	9.11	100	18.8	7.2	8.98	94
1	22.0	8.4	8.38	93	--------	--------	--------	--------
2	21.9	8.4	9.16	100	18.9	--------	8.87	93
3	21.7	8.4	8.68	95	--------	--------	--------	--------
4	20.9	8.4	12.15	131	18.9	--------	8.95	93
5	19.9	6.5	4.22	45	--------	--------	--------	--------
6	19.2	6.2	0.85	9	18.8	--------	8.91	93
7	18.8	6.3	0	--------	18.8 (7.5 m.)	7.5	8.65	90
8	18.7	6.3	0	--------	--------	--------	--------	--------
8.5	18.7	6.3	0	--------	--------	--------	--------	--------
	Transparency 1.8 m. Color forel-ule.				Transparency 2.9 m. Color IX.			

Unfortunately the summer temperature of the lake has never been observed. In comparison with the deep-water temperature in both April and July, the turnover may have been already completed by the beginning of April. Dissolved oxygen was entirely absent in the deep water even in April.

Zoöplankton.—The zoöplankton was very scarce in the number of species and of individuals. In April there occurred only one species of Copepoda, *Thermocyclops hyalinus,* and a rotifer, *Brachionus calyciflorus,* but in January, besides the above-named copepod, there occurred five species of rotifers, of which *Brachionus budapestensis* and *Keratella cochlearis* were most abundant. Rhizopod protozoans were also found.

TABLE 10.—*Composition of plankton of Rigyo-ti.*

Species.	April, 1935.	January, 1937.
	Per cent.	*Per cent.*
Difflugia acuminata		0.3
Arcella vulgaris		0.3
Polyarthra trigla		0.7
Brachionus calyciflorus	0.1	2.5
Brachionus budapestensis		4.9
Keratella cochlearis tecta		4.6
Trichocerca capucina		0.7
Thermocyclops hyalinus	96.0	46.2
Nauplii of Copepoda	3.9	39.8
	100.0	100.0

Phytoplankton.—Contrasted with the paucity of zoöplankton, an enormous quantity of water bloom, consisting chiefly of blue-green algæ and diatoms, appeared even as early as January. Such a remarkable development of water bloom was recorded at no other time in connection with the Formosan lakes studied. The composition of the water bloom, in January, 1937, is shown in Table 11. (determined by Mr. K. Negoro). It is characterized by an enormous occurrence of *Microcystis* species and of *Dimorphococcus lunatus* (green alga). The diatom *Melosira granulata* is also abundant.

TABLE 11.—*Composition of phytoplankton of Rigyo-ti, January, 1937.*

Species.	Per cent.
Microcystis aeruginosa Kütz.	28.5
Microcystis flos-aquae (Wittr.)	2.1
Lyngbya limnetica Lemmermann	6.3

Species.	Per cent.
Dimorphococcus lunatus A. Braun	36.5
Pediastrum, 2 spp.	0.9
Dictyosphaerium sp. and *Westella* sp.	2.2
Scenedesmus quadricauda (Turpin)	0.3
Staurastrum sexangulare (Bulnh.) and *Staurastrum* sp.	0.5
Peridinium sp.	0.2
Ceratium hirundinella (O. F. Müller)	3.2
Melosira granulata (Ehrenberg)	18.4
Synedra sp.	0.9
	100.0

Bottom deposits.—The sediment from the bottom of 8.5 meters is yellowish dark brown and is designated "Algengyttja,"(19, 22) containing a large quantity of diatoms. The amorphous fine detritus which forms the sediment is really derived from the blue-green algæ inhabiting the upper water mass, though the algal structure is not preserved.

TOA-PI

Toa-pi is a small and shallow lake lying north of the town of Taito on the east coast of the island. Its surface area is only 0.53 square kilometers, and no soundings of over 3 meters were obtained in the central part. The altitude of the lake surface is 263 meters above sea level. This lake was visited only once by Miyadi, April 14, 1935. The physical and chemical characteristics of Lake Toa-pi are shown in Table 12.

TABLE 12.—*Physical and chemical characteristics of Toa-pi, April 14, 1935, D. Miyadi.*

Depth.	Temperature.	pH.	Oxygen.	
m.	*°C.*		*mg.*	*Per cent.*
0	21.1	8.9	7.78	89
1	23.6	8.3	7.35	83
2	23.3	7.8	7.57	83
2.8	22.2	7.5	5.05	56
	Transparency 0.7 m.			

Plankton.—No phytoplankton occurs. The zoöplankton is not abundant, consisting chiefly of the copepod, *Thermocyclops taihokuensis*. Table 13 shows the composition of the plankton of Lake Toa-pi.

TABLE 13.—*Composition of the plankton of Toa-pi, April, 1935.*

Species.	Per cent.
Difflugia sp.	0.1
Trichocerca capucina	0.1
Keratella valga tropica	0.5
Filinia longiseta	1.1
Diaphanosoma paucispinosum	6.5
Thermocyclops taihokuensis	91.5
Copepoda nauplii	0.2
	100.0

Bottom deposits.—The bottom mud from a depth of 3 meters is yellowish gray and is characterized as "Feindetritusgyttja," very rich in fine sand, and without diatoms.

SMALL LAKES ON THE CENTRAL MOUNTAINS

A number of small lakes lying on the northern high mountain ranges was investigated by the second expedition in July, 1935. All of them are in the forest zone at altitudes between 2,300 and 2,600 meters above sea level on the ridges around Mount Nanko-Taizan (3,797 meters). Some of these waters were studied by Kano.(12)

The physical and chemical observations made in the field are shown in Table 14.

TABLE 14.—*Physical and chemical characteristics of the mountain lakes.*

Lake.	Altitude.	July, 1935.	Time.		Temperature.		pH.
					Air.	Water.	
	m., ca.		*hr.*	*min.*	°*C.*	°*C.*	
Siron Mahayahen	2,300	20	11	00	22.5	23.0	5.0
Siron Mururoahu	2,300	20	1	00	23.5	25.3	5.2
Myoto-ike	2,200	23	16	00	19.5	19.8	5.8
Zigoky-ike	2,300	23	16	45	17.2	18.5	5.6
Matumine (upper)	2,591	24	8	00	14.0	15.7	5.4
Matumine (lower)	2,500	24	7	40	--------	15.5	5.4
Matumine periodic pool A	--------	23	17	30	16.5	16.3	5.8
Matumine periodic pool B	--------	23	18	00	14.5	15.7	5.4

The water temperature in most cases is below 20°C. The temperature of the upper pond of Matumine, which is the highest elevated lake studied by the expedition, about 15°C., was taken in the morning. The meteorological data obtained by the members of the Matumine policemen's station are cited in Table 15.

TABLE 15.—*Meteorological data at Matumine, for 1934 (at 2 p. m.).*[a]

Data.	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean.
TEMPERATURE, °C.:													
Maximum	9.0	11.7	13.4	20.0	19.0	21.0	21.7	22.2	22.2	18.0	15.6	17.8	22.2
Minimum	—5.5	—1.7	—4.5	3.3	7.2	10.0	12.2	16.7	10.5	7.2	6.1	—3.9	—5.5
Mean	4.0	5.7	4.1	10.2	14.1	16.5	18.6	19.5	16.7	14.4	10.9	10.1	12.0
PRECIPITATION:													
Millimeters	136.0	153.8	552.9	307.0	357.9	268.4	737.8	39.8	310.1	51.4	73.4	32.5	8.28

[a] The original data are given in ° F.

The water of these lakelets is usually acid, the pH values being below 6, and of those surrounded by *Sphagnum* moor as low as 5. From the low pH values of certain periodic pools formed by rain on the preceding day, it is supposed that the acidity of the lakes studied originates from the soil around them, especially in the cases of the Matumine ridge.

Siron Mahayahen.—On the ridge extending in the southeastern direction from Mount Nanko-Taizan (3,797 meters) to Mount Sansei-zan (2,351 meters) there are a number of boglike shallow lakes, of which Siron[4] Mahayahen is representative. It lies in a dense forest of pines at an altitude of about 2,300 meters. It is an irregular ellipse in outline, the greatest length being about 100 meters, and is bordered by the *Sphagnum* moor which is contiguous to the pasture on the southwestern shore. The greatest depth seems to be less than 0.5 meter. The water is clear, but appears to be remarkably brown due to the humic mud covering the bottom. No net phytoplankton was visible, but zoöplankton, restricted qualitatively, was abundant, consisting chiefly of two species of intensely red copepods and the cladocerans *Diaphanosoma brachyurum,* as shown in Table 17. Among the copepodean nauplii found during my visit, the diaptomids were more numerous than the cyclopoids.

Siron Mururoahu.—A very small round body of water with a diameter of some 25 meters, lying at an altitude of about 2,310 meters. It is bordered by *Sphagnum* moor, except for a small hill side on the northeastern side, and is covered with an overgrowth of *Scirpus mucronatus* Linné. The depth is unknown, but it is probably no more than 1 meter. The water is dark blackish brown, due not only to the extract from the marginal moor but also to much wood submerged in the water. The plankton does not differ essentially in composition from that of Siron Mahayahen; a considerable mass of *Diaphanosoma brachyurum* and of intensely red copepods were taken.

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[4] "Siron" means "lake" according to the savage Atayal vocabulary.

Small lakes on the Matumine ridge.—The following four small bodies of water lie in the small fault along the ridge of Matumine, on the western side of the range of Mount Nanko-Taizan. The physical and chemical data obtained by Kano are cited in Table 16.

TABLE 16.—*Physical and chemical analysis of waters of high mountain lakes.*[a]

Lake.	Date.	Time.		Temperature.	pH.	Oxygen.
	Nov., 1933	*hr.*	*min.*	°*C.*		*cc/l.*
Myoto-ike	22	13	10	15.0	6.0	5.33
Zigoku-ike	21	9	00	7.5	6.0	4.82
Matumine (upper)	23	7	00	8.0	5.8	4.05
Matumine (lower)	23	9	00	8.5	6.0	5.55

Lake.	Total solids.	Ca.	Mg.	Cl.	N.	$KMnO_4$ consumed.
Myoto-ike	[a]23.7	[a]0.8	[a]1.5	[a]11.0	[a]0.32	[a]17.0
Zigoku-ike	26.2	1.2	0.5	10.1	0.54	16.5
Matumine (upper)	88.4	1.2	0.6	0.6	1.22	108.0
Matumine (lower)	15.2	1.1	0.4	1.1	0.07	23.0

[a] Figures represent mg per liter of water, except for oxygen and pH.

Myoto-ike.—Elliptical in outline, 50 by 35 meters, with a steep shore, surrounded by pasture and forest pine. Water dark greenish brown. Zoöplankton abundant, consisting of red copepods and *Diaphanosoma brachyurum*.

Zigoku-ike.—A small lake, 30 by 20 meters, nearly circular in outline. Water dark greenish brown. Zoöplankton composed of red copepods and *Diaphanosoma*. *Daphnia pulex obtusa* also found.

Upper pond of Matumine.—A small body of water, circular in outline, only 15 meters in diameter. Water dark reddish brown, typical of the dystrophic water in this district. Zoöplankton very abundant, consisting of intensely red copepods and *Daphnia pulex obtusa*.

Lower pond of Matumine.—A small body of water lying about 1 kilometer north of the above lakelet, nearly triangular in outline; diameter about 10 meters. Water clear but somewhat yellowish brown. Zoöplankton not differing essentially from that of the upper pond, but much less productive.

The zoöplankton of the six lakelets described above is summarized in Table 17.

The plankton of the lakelets studied are, without exception, copepods and cladocerans, neither protozoans nor rotifers being found. The cyclopoid *Tropocyclops prasinus* is distributed in all the waters studied. It is not as abundant as *Neutrodiaptomus tumidus*, which, except for the upper pond of Matumine, is the most important component of all the lakelets studied. This species is endemic to these high mountain waters.

TABLE 17.—*Plankton of small mountain lakes.*

Species.	Siron Mahayahen.	Siron Muruand roahu.	Myoto-ike.	Zigoku-ike.	Matumine upper pond.	Matumine lower pond.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Neutrodiaptomus tumidus, female	16.1	38.3	17.0	37.0	45.4	--------
Neutrodiaptomus tumidus, male	1.9	3.4	3.7	1.9	14.3	--------
Neutrodiaptomus tumidus, young	11.5	--------	6.6	11.0	1.1	--------
Tropocyclops prasinus, female	--------	--------	32.0	4.4	--------	43.3
Tropocyclops prasinus, male	--------	--------	6.8	1.7	--------	13.4
Tropocyclops prasinus, young	9.6	1.4	4.2	0.9	0.4	18.4
Copepoda nauplii	26.0	2.2	21.1	2.1	0.8	4.2
Harpacticoid, undetermined	0.4	--------	--------	--------	0.8	--------
Diaphanosoma brachyurum, female	28.3	54.7	8.6	38.9	--------	--------
Diaphanosoma brachyurum, young	6.2					
Daphnia pulex obtusa, female	--------	--------	--------	1.9	17.8	12.4
Daphnia pulex obtusa, ephippial female	--------	--------	--------	0.2	0.8	--------
Daphnia pulex obtusa, young	--------	--------	--------	--------	16.7	8.3
Daphnia pulex obtusa, male	--------	--------	--------	--------	1.9	--------
	100.0	100.0	100.0	100.0	100.0	100.0

In Siron Mahayahen, Siron Mururoahu, and the upper pond of Matumine, *Tropocyclops prasinus* was represented only by young individuals, while in the other lakelets well-matured animals of both sexes were found. *Diaphanosoma brachyurum* is also an important component in these waters, but does not occur in the lakelets of the Matumine ridge, where it is replaced by *Daphnia pulex obtusa*. *Diaphanosoma paucispinosum*, which occurs in the warm lowland lakes, was never met with in these high mountain lakes. Except in Myoto-ike, in which a small number of green algæ of the genus *Staurastrum* occurred, no visible phytoplankton was found.

Both the calanoid and the cyclopoid copepods in these high mountain waters are intensely carrot-red, as they are in the waters in the alpine regions of Honsyu, Hokkaido, and the Northern Kurile Islands. Such a phenomenon was not observed in any of the lowland lakes studied. I shall discuss this finding in greater detail later.

GENERAL CONSIDERATIONS

COMPOSITION OF THE PLANKTON FAUNA

Table 18 is based upon the series of collections made by our expeditions (compare also with Tables 19 and 20). The phytoplankton is omitted from this table because of its extreme paucity in all the lakes studied except Rigyo-ti.

With regard to the zoöplankton alone, as the writer has already pointed out in another paper,(31) there is a rather close resemblance among the lowland lakes studied. All of them are dominated by one species of Calanoida, *Mongolodiaptomus formosanus* or *M.* (?) *uénoi,* and by any one of the three species of Cyclopoida, *Mesocyclops leuckarti, Thermocyclops hyalinus,* and *T. taihokueneis.* The actual number of Cladocera collected in each lake is much smaller than that of either Copepoda or Rotatoria. In Zitugetu-tan, however, two species of Cladocera, namely, *Ceriodaphnia rigaudi* and *Bosmina longirostris,* are rather abundant, though inferior to the Copepoda, as can be seen in Table 19. The rotifers are numerically the richest species of the zoöplankton in the lakes studied. Ryuran-tan supports the richest variety of this group of animals, though rather few individuals of the respective species. Tables 19 and 20 show clearly this relationship.

It has been known that the rotifers, especially the *Brachionus* species, are abundant in alkaline waters. This is also true in Formosan lowland waters, the pH values of which were usually higher than 7, often as high as 8, and in which the rich variety of *Brachionus* was found.

The plankton of the high mountain lakelets differ greatly from those of the lowland waters. These lakelets in the high mountains support only one or two species of Cladocera and usually

TABLE 18.—*Distribution of zoöplankton in six Formosan lakes.*

	Zitugetutan.	Sangotan.[d]	Kotohi.	Ryurantan.	Rigyo-ti.	Toapiike.
PROTOZOA:						
Difflugia acuminata Ehrenberg	--------	--------	--------	--------	(c)	--------
Arcella vulgaris Ehrenberg	--------	--------	--------	--------	(c)	--------
ROTATORIA:						
Polyarthra trigla Ehrenberg	--------	--------	(c)	(c)	(c)	--------
Trichocerca capucina (Wierz. et Zacharias)	--------	(c)	--------	(c)	(c)	(a)
Brachionus calyciflorus Pallasi	(b)	(a b c)	(c)	--------	(a c)	--------
Brachionus angularis Gosse	--------	--------	--------	(c)	--------	--------
Brachionus forficula laevis Apstein	(c)	(a b c)	(c)	(b)	--------	--------
Brachionus angularis caudatus (Barris et Daday)	--------	--------	--------	(c)	--------	--------
Brachionus budapestensis Daday	--------	--------	--------	--------	(c)	--------
Schizocerca diversicornis Daday	(b)	(a b c)	(c)	(c)	--------	--------
Keratella cochlearis tecta Gosse	--------	--------	(c)	(c)	(c)	--------
Keratella valga tropica Apstein	(c)	(a b c)	(c)	(b c)	--------	(a)
Noteus militaris Ehrenberg	--------	--------	--------	(b)	--------	--------
Monostyla bulla Hudson	(a)	--------	--------	(b)	--------	--------
Filinia longiseta (Ehrenb.)	--------	--------	--------	(b c)	--------	(a)
Tetramastix opoliensis brevispina Ahlstrom	(c)	(b c)	--------	--------	--------	--------
Asplanchna priodonta Gosse	--------	(a b)	--------	--------	--------	--------
Pedalion mirum Hudson	(a b c)	(d)	--------	(c)	--------	--------
Pomphloyx complanata Gosse	(c)	(a)	--------	(c)	--------	--------
CLADOCERA:						
Diaphanosoma paucispinosum Brehm	--------	(a b c)	--------	(a c)	--------	(a)
Diaphanosoma brachyurum (Liévin)	(a b c)	(a b c)	--------	--------	--------	--------
Ceriodaphnia rigaudi Richard	(a b c)	(a b c)	--------	--------	--------	--------
Scapholeberis mucronata (O. F. Müller)	--------	--------	(c)	--------	--------	--------
Bosmina longirostris (O. F. M.)	(a b c)	(a)	(c)	--------	--------	--------
Alona rectangula G. O. Sars	(a)	--------	--------	--------	--------	--------
Alona intermedia G. O. Sars	--------	--------	(c)	--------	--------	--------
Alonella diaphana King	--------	--------	--------	(b)	--------	--------
Chydorus sp.	--------	--------	--------	--------	(c)	--------
COPEPODA:						
Mongolodiaptomus formosanus Kiefer	(a b c)	(a b c)	(c)	--------	--------	--------
?*M. uénoi* Kikuchi	--------	--------	--------	(b c)	--------	--------
Mesocyclops leuckarti (Claus)	(a b c)	(a b c)	--------	--------	--------	--------
Thermocyclops hyalinus (Rehberg)	--------	(a b c)	--------	--------	(a c)	--------
Thermocyclops taihokuensis (Harada)	--------	(a b c)	(c)	--------	--------	(a)

[a] Collection of April, 1935.
[b] Collection of July, 1935.
[c] Collection of January, 1937.
[d] Compare also with Harada. (7, 8)

two species of Copepoda, the latter two of which have never been found in the lowland lakes. This difference is primarily due to the low temperatures that prevail at high altitudes, most of the waters being less than 20°C. in July.

TABLE 19.—*Percentage composition of zoöplankton in six Formosan lakes.*

Group.	Zitugetu-tan.						Sango-tan.			Kotohi.	Ryuran-tan.		Rigyoti.		Toapi.
	([a])		([b])		([c])		([a])	([b])	([c])	([c])	([b])	([c])	([a])	([c])	([a])
	Z.	G.	Z.	G.	Z.	G.									
Protozoa														0.6	0.1
Rotatoria	12.5	63.1	1.1	1.2	10.3	10.2	9.5	29.9	15.5	51.3	1.8	51.1	0.1	13.4	1.7
Cladocera	19.4	10.9	21.7	29.2	27.3	29.2	15.6	14.3	10.8	1.5	5.9	47.3			6.5
Copepoda	68.1	26.0	77.2	69.6	62.4	60.5	74.9	55.5	73.7	47.2	91.1	1.6	99.9	86.0	91.7
Others								0.3			1.2				

[a] Collection of April, 1935. [b] Collection of July, 1935. [c] Collection of January, 1937.

TABLE 20.—*Summary of plankton fauna of Formosan lakes.*

Group.	Zitugetu-tan.	Sango-tan.	Kotohi.	Ryuran-tan.	Rigyo-ti.	Toapi-ike.	Mururoahu.	Mahayahen.	Myoto-ike.	Zigoku-ike.	Matumine (upper).	Matumine (lower).
Protozoa					2	1						
Rotatoria	8	9	6	13	5	3						
Cladocera	4	4	3	2	1	1	1	1	1	2	1	1
Copepoda	2	4	2	2	1	1	2	[a]2	2	2	[a]2	2
Decapoda (larva)				1								
Insecta (larva)		1										
Total	14	18	11	18	9	6	3	[a]3	3	4	[a]3	3

[a] Indicates one or more indeterminate species.

THE PLANKTON AND LAKE TYPE

The oxygen curves obtained in the lowland lakes including Zitugetu-tan are all of the typical form designated as eutrophic (text fig. 1); even in the first half of April the dissolved oxygen in the bottom water of these lakes diminishes greatly or becomes quite anaërobic. This is partly due to the very long stagnation of the lake water and to the warm bottom water, the minimum temperature of which is as high as 18°C. even in January (Rigyo-ti). According to the results of the temperature observations in January, 1937, the water of all these lakes completely circulates, but some of them are not aërated to the bottom, chiefly due to the very short winter stagnation period in these lakes, as is the case in certain deep subtropical lakes in southern Kyosyu.(38) The lakes here concerned may belong to the "incomplete" holomictic type.(38) No true meromictic lakes(4, 5) are present in Taiwan.

Concerning the important nutritive substances, particularly the nitrogen compounds, all the Formosan lakes considered in the present paper may belong to the polytype or mesotype according to Yoshimura's(36) scheme (Table 21). That is to say, the lakes concerned are, without exception, chemically eutrophic.(37) This finding agrees well with the suggestion presented by Ruttner(25) and Thienemann,(27) who concluded that the lakes in the Tropics would usually become eutrophic due to the rapid decomposition of organic matter in them caused by high temperatures.

With regard to the plankton production, there is distinct disharmony as to the chemical composition of the water in almost all lakes studied. In Rigyo-ti there was observed an enormous development of water bloom consisting of blue-green algæ and diatoms as early as January, while in the other lakes the phytoplankton was completely absent or formed a very slight water bloom. In the latter group of lakes the zoöplankton consists chiefly of Crustacea, especially of Copepoda, but is much less productive per unit volume of water than in the lakes of Honsyu or Hokkaido. It is reasonably supposed that in the water of Rigyo-ti such contents of nutritive substances ($N = 0.18$ mg, $P = 0.02$ mg per liter) may be expected to produce a water bloom when there are no other poisonous ions present. In the other lakes, though there are reasonable amounts of nutritive substances in the water, a slight development of water bloom was observed only in Zitugetu-tan.

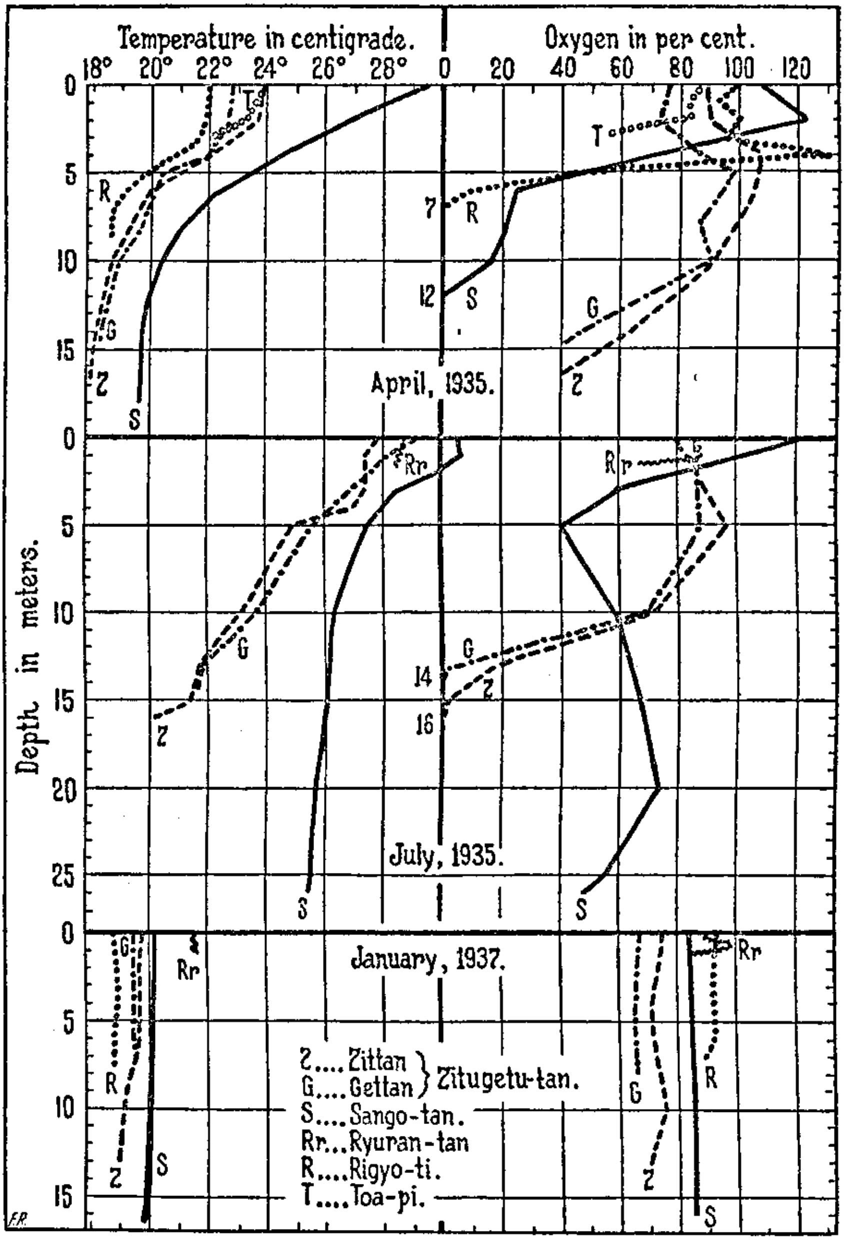

FIG. 1. Depth, temperature, and per cent of oxygen in six Formosan lakes at different times of the year.

TABLE 21.—*Physical and chemical analysis of lake waters of Formosa.*[a]

	Zitugetu-tan.		Sango-tan.		Rigyo-ti.		Toa-pi.
Depth, in meters	0	15	0	16	0	8.5	0
Color [b]	5	5	10	5	20	55	22
Electric conductivity, K 18 10^{-4} ohm^{-1}	3.49	3.61	2.98	3.56	0.83	0.86	4.29
Total solids	206.4	215.6	140.4	224.2	63.5	54.4	347.4
Na	11.3	8.7	-------	7.2	3.1	1.3	16.8
Ca	44.3	50.5	35.8	41.5	13.2	14.4	69.6
Mg	20.1	15.8	14.0	16.2	1.4	-------	0.6
Fe	0	0	0	0	0	0.5	0
Mn	0.05	-------	-------	0.25	0.05	0.7	0
SO_4	41.5	60.8	36.9	31.2	0.8	0	73.5
CO_3	55.6	55.8	51.0	63.0	17.6	19.5	51.0
Cl	0	0	2.9	3.6	1.9	2.0	3.4
SiO_2	8.9	9.1	8.8	9.8	2.6	3.3	10.7
MnO_4 K consumed	27.8	20.8	-------	15.0	16.2	13.7	12.8
N	0.19	0.24	0.34	0.15	0.18	0.39	0.255
P (soluble)	0	0	0	0	0.02	0	0.03

[a] Figures represent mg per liter of water. [b] Platinum-cobalt scale.

Table 21 shows that the water of the lakes concerned, except Rigyo-ti, contains a considerable amount of inorganic salts. There is considerably more sulphate than carbonate in Toa-pi, less in Sango-tan,[5] and the two are nearly of equal quantity in Zitugetu-tan. Such a disharmonic condition of ions may have the effect of restricting the phytoplankton production, but considerable amounts of suspended mineral matter and fine detritus in the water seem to be more effective.[6] The turbidity of the water, which is chiefly due to the flowing in of turbid streams, is usually too great for the free growth of phytoplankton, as will be seen from the transparencies determined by a Secchi white disc.

TABLE 22.—*Transparency of lakes, in meters.*

Lake.	April, 1935.	July, 1935.	January, 1937.
Zitugetu-tan	3.5-3.7	5.0	2.4-3.2
Sango-tan	1.2	0.5	1.2
Ryuran-tan	-------	0.1	0.1
Rigyo-ti	1.8	-------	2.9
Toa-pi	0.7	-------	-------

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[5] The chemical constitution of the water of Sango-tan is discussed more in detail by Harada. (6)

[6] Since the present article was written, Hutchinson's important paper on the limnology of arid regions appeared, (9) in which it was pointed out that the action of the wind on the nutritive condition of desert lakes is important, and that in some of those lakes "the complete absence of living phytoplankton is due to the immense mass of mud in the waters."

Zitugetu-tan is the most transparent; in the other lakes the transparency is very low. Ryuran-tan is the most opaque, being markedly yellow. In these lakes a peculiar association of a large diaptomid (*Mongolodiaptomus*) and *Diaphanosoma* species is characteristic. These zoöplankton may feed on the bacterial and organic material in the suspended matter.

The characteristics of the bottom deposits agree well with the above results. Except for Zitugetu-tan and Rigyo-ti, the bottom deposits of the lakes studied are designated "Feindetritusgyttja" (Lundquist) consisting of considerable fine sand, especially in the case of Sango-tan. The bottom of Zitugetu-tan is covered with the gelatinous mass of a blue-green alga ("Bodenalgenäwja") containing a small quantity of diatoms. The bottom deposits of Rigyo-ti are, on the contrary, in harmony with its production of phytoplankton, which is regarded as "Algengyttja," consisting of amorphous blue-green algæ and of rich diatoms.

The high mountain lakelets differ essentially from the lakes in the low plains, not merely physiographically but biologically. The waters of Myoto-ike and Zigoku-ike are peculiar in that they contain rather large amounts of sodium and chloride, while the upper pond of Matumine, Siron Mahayahen, and Siron Muruoahu contains considerable amounts of humic substance which gives the water a dark-brown color. In their dystrophic condition they appear to be similar to those distributed in high altitudes of middle Honsyu and the northern parts of the Japanese Islands. The humus formation in a warm region such as Formosa too may be commensurate with the increase of altitude, according to Jenny's (11) conclusion that humus content decreases regionally from ½ to ⅓ with every 10°C. increase. One or two species of Copepoda or of Cladocera or both are the only zoöplankton in these waters, though quantitatively abundant.

Summarizing the data discussed above, the lakes and lakelets studied may be divided into the following groups:

A. Eutrophic Lowland Lakes.
  Aa. Eutrophic type without an intense development of water bloom, including Zitugetu-tan, Sango-tan, Kotohi dam, Ryuran-tan, and Toa-pi. These lakes contain considerable amounts of salts, especially sulphate or carbonate of lime (gypsotrophic phase). Zoöplankton characterized by Copepoda and Cladocera. Bottom deposits often contain considerable amounts of fine sand.
  Ab. Eutrophic type with an enormous appearance of water bloom (ortho-eutrophic), including Rigyo-ti. Zoöplankton very scarce; blue-green algæ and diatoms dominant. Bottom deposit characterized as "Algengyttja," rich in diatoms.

B. Mesotrophic high mountain lakelets:
  Ba. Polyhumus type including Siron Mururoahu, Siron Mahayahen, the upper pond of Matumine; water coffee brown; characterized by intensely red copepods and by one or two species of Cladocera.
  Bb. Meso- or oligohumus type, including Myoto-ike, Zigoku-ike, and the lower pond of Matumine; water dark greenish brown or brown; the plankton does not differ essentially from that of Ba.

The lakes lying in the low plains and even as high as 740 meters above the sea (Zitugetu-tan) are without exception in a eutrophic condition, while those in the high mountain lakelets are in a eutrophic condition of less advanced stages or dystrophic.

OCCURRENCE OF RED COPEPODS IN FORMOSAN HIGH MOUNTAIN WATERS

Since Zschokke (40) noticed the occurrence of red copepods in lakes of high altitudes, the red coloring phenomenon of copepods called "Alpine Rotfärbung"(40) has been discussed by many ecologists for many years.[7] In the high mountain lakelets of Formosa studied, red copepods also occur very abundantly, as stated above. This phenomenon is also observed in many waters in the high altitudes of middle Honsyu, as well as in the northern parts of Japan.

The calanoid *Acanthodiaptomus yamanacensis* (Brehm) is the only representative red copepod inhabiting the waters in the districts south of Hokkaido, but in the northern Kurile Islands most of the species of Copepoda, including the above calanoid, living in the shallow bodies of waters showed intensely red coloring.(20) The fact that the red coloring of copepods is much more intense in the north or in high altitudes suggests the lowering of the water temperature of their habitats as the most important factor causing the red coloring, as suggested by Zschokke (40) and other authors succeeding him. *Acanthodiaptomus yamanacensis* shows, however, a red color in certain volcanic lakes in the low plains of Honsyu and Hokkaido, as also noticed by Elster(3) and Valkanov,(34) who found red copepods in the waters in the forest zone in Europe. On the other hand, several ecologists have noticed the relation between the red color of copepods and the phytoplankton. In this connection we owe much to Blaas,(1, 2) who concluded that the red color of copepods was due to the nature of the water in which they live as well as to the richness of nannoplankton, especially the minute algæ which are a source of food for copepods.

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[7] For the references to this subject, see Pesta.(24)

Acanthodiaptomus yamanacensis is a eurythermal calanoid widely distributed throughout the Japanese Islands, from the Kuriles to southern Kyusyu, Korea, as well as in Manchoukuo and Kamtchatka. It shows a red color in waters that are weakly or strongly acid (pH 4 to 6.8) and are mostly oligotrophic or dystrophic rather than eutrophic; in alkaline waters it usually shows no red color. A similar result has been obtained in the Formosan high mountain lakes, the waters of which are weakly acid (pH lower than 6, see Table 14), red copepods (*Neutrodiaptomus tumidus* and *Tropocyclops prasinus*) being found in them abundantly. It seems therefore that the acidity of the water is an important cause of red color in copepods.

Uéno et al.(29) isolated three kinds of carotinoid pigments, β-carotin ($C_{40}H_{56}$), astacin ($C_{40}H_{48}O_4$), and a new carotinoid, from the body of *Acanthodiaptomus yamanacensis* of Lake Sikotu, Hokkaido. Astacin, which is an acid carotene distributed in many Crustacea,(17, 39) is the most important constituent of the red color of this calanoid. Astacin is produced in the copepodean body by the oxydation of β-carotin, which is most widely distributed in the plant world. According to this view it is quite possible that the nannoplankton algæ serve as an important source of β-carotin, and that the carotinoid pigments thus formed are deposited in the fatty parts of the body due to their fat-soluble nature, and in consequence give an intense red color to the organisms. When *Acanthodiaptomus yamanacensis* lives in acid water the color waxes of astacin may remain stable in the body, but when it inhabits an alkaline water the pigments may dissolve out of the body by saponification because of its acid nature. If this be so, the red color of copepods has but an ecological significance; that is, the copepod gets energy produced in the process of oxidizing β-carotin to astacin in its body, so that the pigment may be a useless substance for the organism. More detailed experimental studies are needed, however, to clear up his puzzle.

The habitats of intensely red copepods in Formosa are cold and acid waters, as is the case in Japan, north of this island. Recently Hutchinson (9, p. 143) found "the smaller intensely red copepods" inhabiting the extremely alkaline water (pH 9) of Tso Moriri of the Indian Tibet.

SUMMARY

1. Plankton of six lowland lakes and six high mountain lakelets in Taiwan, Formosa, is reported, together with physical and chemical observations on these bodies of water.

2. Phytoplankton is very scarce, an enormous development of water bloom being observed in only one lake, while these lakes are in general to be regarded as eutrophic. The zoöplankton consists chiefly of Copepoda and Cladocera, of which the former are usually dominant in the lakes.

3. It is suggested that the presence of considerable amounts of suspended matter and of dissolved salts in the waters would probably produce a marked effect on the production of plankton, especially on the growth of phytoplankton.

4. The high mountain lakelets differ greatly from the lakes in the lowland as to the nature of the waters and as to the plankton. The zoöplankton consists of only one or two species of either Copepoda or Cladocera, which belong to the species different from those in the lowland lakes.

5. Intensely red copepods, due probably to astacin, occur in the high mountain lakelets, where the waters are usually acid, as is also the case in corresponding Japanese lakes and lakelets.

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ILLUSTRATIONS

PLATE 1

[Photographs by the author.]

FIG. 1. Zitugetu-tan. View from the northeastern shore of the Zittan basin, looking south. Taken July 15, 1935.

2. Matuminé upper pond. Taken July 24, 1935.

3. Siron Mahayahen. Taken July 20, 1935.

TEXT FIGURE

Depth, temperature, and per cent of oxygen in six Formosan lakes at different times of the year. 67

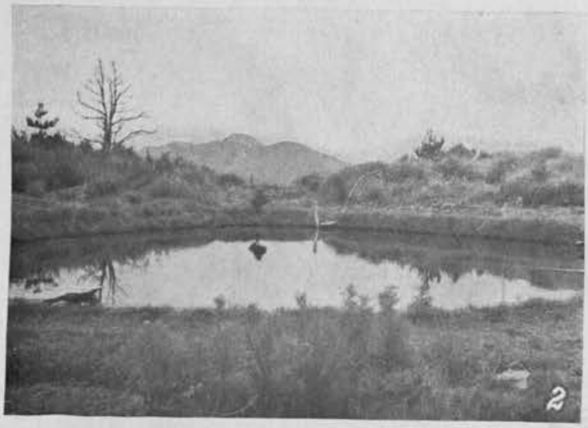

PLATE 1.

FISH-FRY INDUSTRIES OF THE PHILIPPINES

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TWO PLATES AND NINE TEXT FIGURES

The abundance of marine as well as fresh-water species of fish in the Philippines accounts for the presence of numerous kinds of pelagic and demersal fish eggs and larvæ in our waters. The coastal waters and the mouths of rivers, as well as tidal creeks where numerous species of fish spawn or where the juvenile stages of aquatic life drift from the deep-water breeding places, are especially rich in fish eggs and fry. The breeding or spawning activities of most species of our food fishes are periodic, so that the occurrence in large numbers of fish fry or larvæ is also periodic. Consequently the commercial utilization of fish fry in the Philippines is generally confined to certain seasons of the year.

For the last few years the Fish and Game Administration has undertaken the survey of fishing grounds for larval fishes; like bañgos fry, goby fry, and siganid fry. Although the commercial exploitation of larval fishes is believed by many to have but little effect on the abundance or scarcity of fish, yet our observation reveals that the wholesale capture of larval fishes both for stocking fishponds and for the manufacture of *bagoong* and other forms of preserved fishery product is partly responsible for the obvious depletion of many of our fishing banks.

The larvæ of the bañgos, *Chanos chanos* Forskål, have, from time immemorial, been the subject of great commercial interest to fishpond operators. In fact, the bañgos-fry industry is easily worth 1,000,000 pesos annually to the municipalities of the Philippines that border sandy seacoasts.

The larvæ of other species of fish which are of commercial importance are also dealt with in this paper, as well as regulatory and remedial measures for the protection of these larvæ and for the rehabilitation of depleted fisheries.

MILKFISH-FRY (BAÑGOS) FISHERIES

The study of the bañgos-fry fisheries of northwestern Luzon was undertaken from March to June, 1936, primarily to determine the conditions and importance of the fisheries, and secondarily, to recommend measures for their improvement.

With the increasing number of bañgos-fishpond operators in the Visayan Islands, especially Negros and Panay, there is a tendency of cutting the supply of bañgos fry to Manila from that region. The Formosan Government is also trying to import from the Philippines bañgos fry of a certain size for use as live bait in tuna fishing.

The yearly demand for bañgos fry by bañgos-fishpond operators around Manila Bay (in Rizal, Bulacan, Pampanga, Bataan, Pangasinan, La Union, and Zambales Provinces, where the investment in fishponds amounts to over 50,000,000 pesos) has led to the extensive development of the bañgos-fry industry in Ilocos Norte, Ilocos Sur, La Union, Batangas, Cebu, Antique, and Negros Provinces.

The catching of bañgos fry from March to June is seasonal, like that of catching goby fry. During this period the milkfish, *Chanos chanos,* spawns in waters not far from sheltered bays, coves, and gulfs, whence immense numbers of fry eventually drift towards shallow sandy coasts. The bañgos is one of the most prolific of fishes; a ripe female may have from 3,000,000 to 5,000,000 ova, depending upon its size.

The small transparent bañgos fry swim in schools. They enter rivers, estuaries, and tidal creeks with advancing high tide.

Fry of other fishes that go in schools with the bañgos fry from March to June are *Ambassis* spp. (*dañgat* or *begsang*), *Mugil* spp. (*aligasin* or *sarabab*), *Therapon cancellatus* (Cuv. & Val.) (*bagaong* or *baraongan*), *Sphyræna obtusata* (Cuv. & Val.) (*babayo*), Soleidæ (*dadali*); *Scatophagus argus* (Linnæus) (*malaga*), *Megalops cyprinoides* (Broussonet) (*buan-buan* or *bulan-bulan*), *Sillago sihama* (Forskål) (*asohos* or *osohos*), *Leiognathus caballus* (Cuv. & Val.) (*sapsap*), *Amphacanthus virgatus* (Cuv. & Val.) (*kuyog, yomoyobyob* or *kuing*), *Caranx ignobilis* (Forskål) (*pepikat* or *maliputo*), *Caranx marginatus* Gill (*muslo*).

Larval stages of shrimps and prawns, and zœa and young stages of crabs such as *alimañgo, katang,* and *alimasag* are also included in the catch. The destruction of larval crustaceans also causes the depletion of the crustacean fauna of a given region.

Bañgos-fry catchers or collectors throw away larvæ of other fishes that are caught with the bañgos fry. This practice is against the policy of the Fish and Game Administration of conservation and utilization of fish larvæ for stocking tidal creeks, rivers, and lakes. If the bañgos-fry fishermen return the undesirable fry back to the sea or farther up the stream or creeks, the same fry will be caught in their traps, because tides usually bring these animals back to the shores. Another way in which other marine larval fishes are wasted is by the pollution of some tidal creeks or estuaries due to the retting of maguey leaves in places where retting is done on a large scale, as in the Ilocos region. Fishes, crustaceans, and mollusks do not survive in polluted waters and it would be of no value for the bañgos-fry collectors to liberate other larval fish in such places.

The importance of the bañgos-fry industry of the coastal towns of the Ilocos and the Batangas, Cebu, and Negros Provinces.—In Ilocos Norte Province bañgos fry are caught along the coast, at the mouths of Laoag, Puyupuyan, Bacarra, Caaoacan, Mangato, and Callaguip Rivers, and at the mouths of the small tidal creeks of the municipalities of Burgos and Badoc.

In 1934 the income from bañgos-fry leases was 2,225.25 pesos;[1] in 1935, 2,300.90 pesos, and in 1936, 3,757 pesos (Table 1), showing an increase of 1,456.10 pesos, or 63 per cent. It has been estimated that from March to June, 1936, around 14,638,000 bañgos fry, or 7,319 jars, were caught in Ilocos Norte Province. This quantity was valued at approximately 36,595 pesos (Table 2).

TABLE 1.—*Fees from bañgos-fry leases in Ilocos Norte Province.*

Municipality.	1934.	1935.	1936.
	Pesos.	*Pesos.*	*Pesos.*
Bangui	----------	60.00	----------
Burgos	150.25	102.40	100.00
Pasuquin	205.00	205.00	550.00
Bacarra	60.00	120.00	410.00
Laoag	700.00	600.00	905.00
Paoay	1,110.00	1,130.00	1,625.00
Badoc	----------	83.50	167.00
Total	2,225.25	2,300.90	3,757.00

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[1] One peso equals 50 cents United States currency.

TABLE 2.—*Approximate number and value of jars of bañgos fry caught from March to June, 1936, in Ilocos Norte Province.*

Town.	Fishing locality.	Jars.	Value.
			Pesos.
Burgos	Buran-Bubon	97	485.00
Pasuquin	Puyupuyan River and marine shores	521	2,605.00
Bacarra	Bacarra River and marine shores	391	1,955.00
Laoag	Caoacan River, Laoag River, Mangato River, marine shores	3,500	17,500.00
Paoay	Callaguip River and marine shores	2,500	12,500.00
Currimao	Gaang shores	60	300.00
Badoc	Gabbet marine shores Lugo-Pagsanaan	250	1,350.00
	Total	7,319	36,595.00

In Ilocos Sur Province bañgos fry are caught along the coasts, tidal creeks, estuaries and mouths of rivers of nearly all the seacoast towns. Here the fees derived from the lease of bañgos-fry grounds in 1934 amounted to 5,938 pesos; in 1935, to 9,761 pesos, with an increase of 3,823 pesos, or 64 per cent; in 1936 the fee was 12,975.20 pesos, or 34 per cent more than that in 1935 (Table 3). The significant increase in fees is due to the very keen competition among bañgos-fry dealers in offering high bids to obtain good bañgos-fry grounds. The approximate numbers of jars of bañgos fry caught from March to June, 1936, was 12,460, valued at 62,300 pesos (Table 4).

TABLE 3.—*Fees from bañgos-fry leases, Ilocos Sur Province.*

Municipality.	1934.	1935.	1936.
	Pesos.	*Pesos.*	*Pesos.*
Sinait	350.00	410.00	951.99
Cabugao	1,010.00	1,010.00	1,010.00
Lapog	60.00	129.00	156.00
Magsingal		800.00	790.00
Santo Domingo	500.00	1,540.00	2,621.21
Santa Catalina	30.00	30.00	
Caoayan	150.00	155.00	335.00
Santa	117.00	55.00	
Narvacan	800.00	1,850.00	2,501.00
Santa Maria	1,197.00	1,676.00	2,500.00
San Esteban			215.00
Santiago			315.00
Candon	570.00	700.00	700.00
Santa Lucia			800.00
Santa Cruz	1,154.00	1,406.00	
Total	5,938.00	9,761.00	12,975.20

TABLE 4.—*Approximate number and value of jars of bañgos fry caught from March to June, 1936, in Ilocos Sur Province.*

Town.	Fishing locality.	Jars.	Value.
			Pesos.
Sinait	Dadalaquiten, Teppeng, Pugos, Cabangtalan	908	4,540.00
Cabugao	Pugos, Daclapan	963	4,815.00
Lapog	Nagcabibian, Sabangan Buaya, Saoang, Quisit	200	1,000.00
Magsingal	Marine shores	754	3,770.00
Santo Domingo	Namonoan tidal creek and marine shores	2,500	12,500.00
Caoayan	Pandan shores, Bagoc tidal creek	358	1,790.00
Santa	Sabangan Niog, Agayayos		
Narvacan	Marine shores, Paratong	2,386	11,930.00
Santa Maria	Biao, Suso tidal creek, and marine shores	2,385	11,925.00
San Esteban	Marine shores	200	1,000.00
Santiago	Marine shores	300	1,500.00
Candon	Paypayad, Tamorong	671	3,355.00
Santa Lucia	Marine shores	835	4,175.00
Santa Cruz	Davao River, Dile River, Marine shores		
	Total	12,460	62,300.00

In La Union Province bañgos fry are caught at Darigayos River at Balaoan; Marigay River, and Ballogo barrio of Bacnotan; marine shores of San Fernando; marine shores and estuaries of Bauang; and shores of Santo Rosario and Santa Lucia of Ariñgay. Other bañgos-fry grounds of La Union Province have not been leased, due to high fees. In this province the collection for bañgos-fry leases in 1934 was 4,086 pesos; in 1935, 4,424 pesos. The fee for 1936 increased to 6,869.85 pesos (Table 5). The estimated number of jars of bañgos fry caught in 1935 was around 8,500, valued at 42,000 pesos.

TABLE 5.—*Fees from bañgos-fry leases in La Union Province.*

Municipality.	1934.	1935.	1936.
	Pesos.	*Pesos.*	*Pesos.*
Bangar			680.00
Bacnotan	770.00	600.00	908.98
Luna			900.00
Balaoan		720.00	751.00
San Juan			970.37
San Fernando	2,110.00	1,521.00	1,627.50
Bauang	500.00	812.00	855.00
Cava			25.00
Aringay	706.00	771.00	152.00
Total	4,086.00	4,424.00	6,869.85

The revenue derived by the Ilocos provinces from bañgos-fry ground leases in 1934 amounted to 12,249.25 pesos; in 1935, to 16,486.40 pesos, and in 1936, to 23,602.06 pesos (Table 6). The value of bañgos fry caught annually in northwestern Luzon and sold in these places is estimated at not less than 140,000 pesos.

TABLE 6.—*Fees from bañgos-fry leases in the Ilocos provinces.*

Province.	1934.	1935.	1936.
	Pesos.	*Pesos.*	*Pesos.*
Ilocos Norte	2,225.25	2,300.90	3,757.00
Ilocos Sur	5,938.00	9,761.50	12,975.20
La Union	4,086.00	4,424.00	6,869.85
Total	12,249.25	16,486.40	23,602.05

In Batangas Province the catching of bañgos fry is also an important industry from April to July. The annual fee derived from the leasing of bañgos-fry grounds amounts to about 50,000 pesos. Bañgos fry begin to appear in Balayan Bay and its contiguous waters in March and disappear in July, but the height of the season is in April, May, and June. The season of abundance of bañgos fry in the coastal waters from Nasugbu to Calatagan, Batangas, is similar to that of Balayan Bay.

Table 7 gives the value of the partial count of fry caught during the bañgos-fry season from 1930 to 1935, inclusive, showing a yearly average catch of 4,197,000 bañgos fry, valued at 4,197 pesos.

TABLE 7.—*Bañgos fry in coastal waters from Nasugbu to Calatagan, Batangas Province.*

Period.	Number of fry.	Value at 10 centavos per 100.
		Pesos.
April-July, 1930	2,022,000	2,022.00
April-June, 1931	4,352,000	4,352.00
April-June, 1932	3,208,000	3,208.00
April-July, 1933	5,696,000	5,696.00
April-July, 1934	2,382,000	2,382.00
April-June, 1935	6,502,000	6,502.00
Average per year	4,197,000	4,197.00

Table 8 shows a partial count of the bañgos fry caught at Balayan Bay within the vicinity of Lemery, Batangas Province.

TABLE 8.—*Partial count of bañgos fry collected from Balayan Bay within the Lemery municipality during 1935.*

Period.	Number of fry.	Value at 10 centavos per 100.
1935		*Pesos.*
April 10–30	740,315	740.32
May 1–28	2,288,320	2,288.32
June 7–17	953,490	953.49
Total	3,982,125	3,982.13

Table 9 shows a partial count of the bañgos fry collected from the Palanas tidal waters of Lemery, Batangas Province.

TABLE 9.—*Partial count of the bañgos fry collected from Palanas tidal waters, Lemery, Batangas Province, during 1935.*

Period.	Number of fry.	Value at 10 centavos per 100.
1935		*Pesos.*
April 10–30	27,700	27.70
May 1–22	41,900	41.90
June 11–15	23,500	23.50
Total	93,100	93.10

The fisheries of Lake Taal and Pansipit River have apparently decreased, due partly to the injudicious destruction of larvæ, fry, and fingerlings of fishes other than the bañgos fry migrating from Balayan Bay to Taal Lake and Pansipit River.

Manila gets its supply of bañgos fry from Cebu, Panay, and Negros. At present no records are available of the quantity and value of the bañgos fry caught in the bañgos-fry grounds of the Visayas.

The conditions and system of leasing and working out bañgos-fry concessions.—Any municipality in any of the Ilocos provinces or in any regions of the Philippines having good bañgos breeding grounds usually leases annually from March to June to the highest bidder the exclusive privilege of catching bañgos fry. Usually the contracts of lease are made after the bids for the bañgos-fry grounds are made, in December or January.

The reasons for the practice of auctioning off bañgos-fry grounds of the municipalities are as follows: (*a*) It is the most effective and surest source of higher revenue; if the fishing appliances for bañgos fry are licensed in accordance with fixed minimum rates the income is less; (*b*) there is union among bañgos-fry fishers of each concession, so that a concessioner can assure the bañgos-fishpond owners an adequate supply of bañgos fry.

Although the reasons for the continuation of the lease of bañgos-fry grounds are good, there are also considerable defects in this practice. In the first place, it enables a few individuals to monopolize the taking of fry. Local fishermen are deprived of the privilege of catching bañgos fry in season, because of the well-organized union of bañgos-fry dealers who recruit their bañgos-fry catchers from Pangasinan and Pampanga provinces.

The bañgos-fry industry is monopolized by a few bañgos-fry dealers from Pampanga, Pangasinan, and Rizal provinces, each having a crew of 10 to 20 persons in each of their bañgos-fry concessions. Each fisherman is paid a monthly salary of 15 to 20 pesos, with free board and lodging. The head of the crew supervises the building of the bañgos-fry shed, the constructing of the saplar, the fixing of the nets and jars, the catching of bañgos fry, and the preparation of bañgos-fry jars for shipment. A fisherman in the fishing barrio may catch bañgos fry in a bañgos-fry concession on condition that he receives one-half of the value of his catch.

Methods of catching bañgos fry.—Three methods which have been introduced by the Tagalogs and Pampangeños in northwestern Luzon are used in catching bañgos fry; namely, *saplad* or *saplar, sayod,* and *sagap.*

The saplad, or saplar (Plate 1, fig. 1), is employed at the mouths of rivers, estuaries, and tidal creeks. The gear consists of a V-shaped barricade of crushed bamboo (*tinidtid*), which is set firmly at the bottom ground. At the point of intersection of the tinidtid walls is a gate through which the fry pass into the saplar proper, a half-hoop net of sinamay 1.5 meters long and 2 feet wide attached by means of strings to two parallel bamboo poles, facing down-stream. The saplar is set in shallow water about a meter high. A number of saplar might be used to cover the entire width of a tidal creek.

The sayod is a seine made of coarse sinamay, about 1.5 meters wide and 5 meters long. Two fishermen, one at each end of the sayod, drag the device along the shore until a great number of fry are caught.

The sagap (Plate 1, fig. 3) is similar to the *bintol* for catching shrimps. It is a rectangular sinamay net 1 meter wide and 2 meters long, with sinamay walls. It is mounted on two crossed bamboo slats, each 3 meters long, 2 inches wide, and 0.5 inch thick. It also is operated by two fishermen along shores and along margins of mouths of rivers.

Methods of counting and acclimatizing the fry.—The fry are dipped from the saplad, sayod, or sagap with a basin; debris are removed with a small bamboo broom. When fry of other fishes are numerous, it is necessary to sort out the bañgos fry with an open-top cylinder of wire netting, 11 inches high, 6 inches in diameter, and a mesh of 1.5 square millimeters, large enough for the tiny bañgos fry to pass through. When the sieve is used, it is partly immersed in a large basin of water where the fry from a smaller basin are poured into the sieve. Fry of other fishes that remain in the sieve are discarded as stated elsewhere.

The method of counting the fry is a tiresome operation. The counters use the *palayok* system. They have on hand one thousand pebbles or small shells as counters. One man counts the fry in a small bowl or clam shell (*cappo*) which he uses for dipping out the fry from one container into another. After each count he calls out the number of fry in the dipper. Another man separates a corresponding number in counters. This process is continued until a thousand is counted. The density of one thousand fry in a basin is used as a basis for the other thousands of fry which are put in jars. A jar of 20- to 30-liter capacity usually holds from 2,000 to 3,000 fry.

The water in the jars of fry which is at first salty is gradually diluted with fresh water so that the fry can be kept in the jars a longer time, and the use of sea water in transit avoided in case the fry are sold to buyers far away from the coast. Then the jars are covered with leaf sheaths of betel palms ready for transit. The bañgos fry cannot stand more than two weeks without feeding, so the jars of bañgos fry must reach the rearing ponds in the Central Luzon provinces before the end of two weeks.

The mortality of the bañgos fry in the jars while in transit is from 5 per cent to 20 per cent, depending upon the distance. Mortality is due to: (*a*) Overcrowding and insufficient oxygen in the water; (*b*) the lack of food for the fry as the embryonic yolk is gradually absorbed in the process of postlarval development, when fins, body, and head regions develop; (*c*) the presence of protozoan fish parasites that may attach themselves to the fins, body, and vent of the fry, gradually reducing its vitality and effecting its death; (*d*) long transit generally weakens bañgos fry.

The price of bañgos fry in the Ilocos provinces, Pangasinan Province, and the central provinces varies according to the catch of each month. In March the price of one jar of 2,500 to 3,000 bañgos fry is from 2.50 pesos to 3 pesos. In April the same number of bañgos fry brings 3 pesos to 3.50 pesos per jar. In May, the height of the season, when the catch is greater, the price ranges from 2 pesos to 2.60 pesos per jar of fry. In June and July, when the catch is less, the price goes up to from 3.50 pesos to 5 pesos per jar of 2,500 to 3,000 bañgos fry.

Natural factors, such as occasional floods during the rainy season, may destroy the bañgos fishponds of Pangasinan, La Union, and other provinces, liberating thousands of yearlings or 6-month-old bañgos. In the following bañgos-fry season there is a tendency for the price of bañgos fry to rise, due to increased demand. The price of one jar at such times is from 7.50 pesos to 10 pesos, and even as high as 15 pesos or 25 pesos a jar of 2,000 to 3,000 fry. In the succeeding bañgos-fry seasons there may also be a corresponding decrease in the prices of bañgos fry, due to the increase of the bañgos breeders in the sea.

Bañgos-fry dealers and fishpond owners of Bulacan, Pampanga, Bataan, and Pangasinan provinces, usually buy the fry from northwestern Luzon and the Visayas, and rear them in the fry-rearing ponds.

Recommendations.—The fry of the migratory fishes that are caught with the bañgos fry should be collected and planted farther up in tidal creeks or rivers.

The retting and washing of maguey fiber must be confined to the shores where water pollution is absent. It should be prohibited in fish nurseries, such as tidal creeks, estuaries, and rivers.

The saplar, when in use, should not block completely a stream, estuary, tidal creek, or the mouth of a river; at least one-third of the mouth of a stream, river, estuary, or tidal creek must be left open for the passage of migratory fishes, boats, rafts, and launches.

The lessees should keep a record of the quantity of bañgos fry caught (number of jars) from March to June and submit a report after each season to the municipal mayor who in turn will submit such records to the Fish and Game Administration for statistical purposes.

A durable and cheap container should be made and tried in the transportation of fish fry. The earthen jar (palayok) is breakable, expensive, and delicate for shipment.

Life history studies should be made during the bañgos-fry season. Very little is known of the spawning and breeding habits of bañgos.

GOBY-FRY (IPON) FISHERY

The investigation of the ipon fisheries of northern Luzon was started in November, 1934, and continued in 1935. The primary object of the work was to look into the possibilities of regulating the fisheries in order to protect the industry from depletion. Like other natural resources regularly drawn upon by man, the ipon fishery is subject to over-fishing. In fact, the ipon fishery, including in its activities only the fry of migratory gobies and eleotrids, is more intensely affected by overfishing than the fishery of adult fish.

For the purpose of formulating regulatory measures for the conservation and protection of the ipon fisheries of northern Luzon, the fishery devices used in catching the ipon, the volume of the upstream migration of the fry, and certain aspects of the biology of the fish that supply the ipon were studied.

The goby fry are the larval stages of various species of gobies, known as ipon in Iloko. The known sources of ipon of northern Luzon are *Chonophorus melanocephalus* (Bleeker) (*bukto* Ilk.); *Chonophorus ocellaries* (Broussonet) (*bunog* Ilk.); *Eleotris melanosoma* (Bleeker) (*virot* Ilk.); *Glossogobius celebius* (Cuvier and Valenciennes) (*balla* Ilk.); *Ophiocara aparos* (Bleeker) (*dulong* Ilk.); *Rhyacichthys asparo* (Kuhl and van Hasselt) (*campa* Ilk.); *Sicyopterus lacrymosus* (Herre) (*paliling* Ilk.).

From June to November the adult gobies descend periodically to the sea to spawn. The occasional floods in the river systems of northern Luzon during the rainy seasons destroy the hiding places upstream of the gobies. Thus the river currents carry the gobies away to the sea periodically, the latter stopping wherever they can to feed. During this down-stream migration of the sexually mature gobies they are sometimes caught with the *kitang* (set lines), *palamag* (bombon or bunches of debris submerged in water), and *cubong-cubong* (bamboo tubes).

About 40 per cent of the sexually mature gobies are caught from June to August, while the fishermen engaged in this capture are very few in comparison with the number of fishermen catching goby fry.

The spawning habits of the larger species of gobies are not definitely known. Herre (1927) stated that the eggs of *Glossogobius giurus* (*bia* Tag., *balla* Ilk.) are laid underneath rocks near the mouths of rivers, where they are affected by tides. When sexually mature the bia is about 22 to 144 millimeters long; *Chonophorus melanocephalus*, 20 to 120; *Eleotris melanosoma*, 20 to 100.

The breeding habits of the minute lake-dwelling gobies, *Mirogobius lacustris* Herre and *Mirogobius stellatus* Herre, have been studied. These species of gobies are sexually mature at a length of about 2.5 centimeters. The ripe female extrudes the eggs singly. The eggs are about a millimeter in diameter. They adhere to aquatic plants or other objects by means of external threads. They are fertilized by the male either when they are still attached to the vent of the female or when they are attached to aquatic plants. The embryo develops in three days and the eggs hatch on the fourth or fifth day, depending upon the temperature.

Although our knowledge of the breeding habits of large species of gobies is very meager, we know from repeated observation the periodic appearance of vast shoals of ipon during high tides nine days following the full moon of each month from September to February, and extending to even as late as March along the Ilocos coastal regions and the northern coast of Cagayan Province. The ipon are brought in by the incoming high tide, going in schools as they enter the mouths of rivers.

In the Ilocos regions there are six so-called "runs" of ipon, known in Iloko as *apta*, for September; *pasaran* in October; *papait* in November; *lumaladec* in December; *paturay* in January, and *salsalput* in February.

The parr marks of the ipon of each of the runs indicate that they are the heterogenous larval stages of the bukto, bunog, balla, campa, and paliling. As the ipon migrates, it feeds on algæ or plankton. Then appear the changes in color, from transparent white to the characteristic parr marks or cross bars and pigments of the adult. The ipon which are now usually 2.5 centimeters long develop into various species of gobies ranging in length from 8 to 25 centimeters.

Methods for catching goby fry.—Fishing starts along the coast as soon as the goby fry are sighted with the incoming high tide. Catching ipon with the nets along the coast and at river mouths lasts from one to four days, while farther upstream fishing with barricade traps may last for a week.

The fishing appliances used in catching the goby fry along the seashore are various types of ipon nets or seines, known in Iloko as *daclis, tangar, garamgam,* and *tuad.* Along the rivers varied styles of barricade traps of bobo and hoop nets are the most effective devices used in catching the ipon in their migration farther up the stream. , These traps are known also as *pamoboan, piñgi, sarep, pataya, pasalugqui, lel-len, paculod, paed, paayas, padàit, pamalibtocan, burayoc,* and *etter.* The simplest gear is known as *caput.*

The seine, *daclis de ipon,* is made of coarse cotton cloth or sinamay. The conical bag of the seine is about 20 meters long, its left and right wings each 25 meters long, 3 meters at their widest portion, and 2 meters wide at their ends. The accessory parts of the wings are wooden or bamboo floats 4 inches long and 3 inches in diameter, attached 1 foot apart along the corkline, and the earthen weights, 3 inches long and 3 inches in diameter, which are strung to the bottom line or ground rope, 1 foot apart. The bamboo brails are tied to the wing bridle about a meter away from the ends of the wings. The free ends of the corkline and the ground rope form the wing bridles to which are joined the 200-meter pull ropes.

The *chinchorro* (daclis de ipon) is operated along gradually shelving shores and at the mouths of rivers. When enclosing a school of ipon, small boats (viray) or large bamboo rafts are necessary to accommodate a part of the crew and the ipon nets. As soon as the crew of the ipon net and boat have thrown the daclis de ipon in a semicircular manner along the beach or at the mouth of the river, the pull ropes are pulled by several persons. The wings of the nets are dragged slowly in such a way as to concentrate the catch into the bag of the seine. Fifty to seventy-five persons are needed in the operation of the daclis de ipon. A single haul of an ipon net catches from 2 to 8 cavanes during the height of the season. (Plate 2, figs. 1 and 2.)

A daclis de ipon outfit may cost from 500 pesos to 650 pesos. The small boats (viray) cost from 250 pesos to 300 pesos each, and the ipon nets, 200 pesos to 350 pesos. One man may own one ipon outfit, or several persons may own a single ipon outfit.

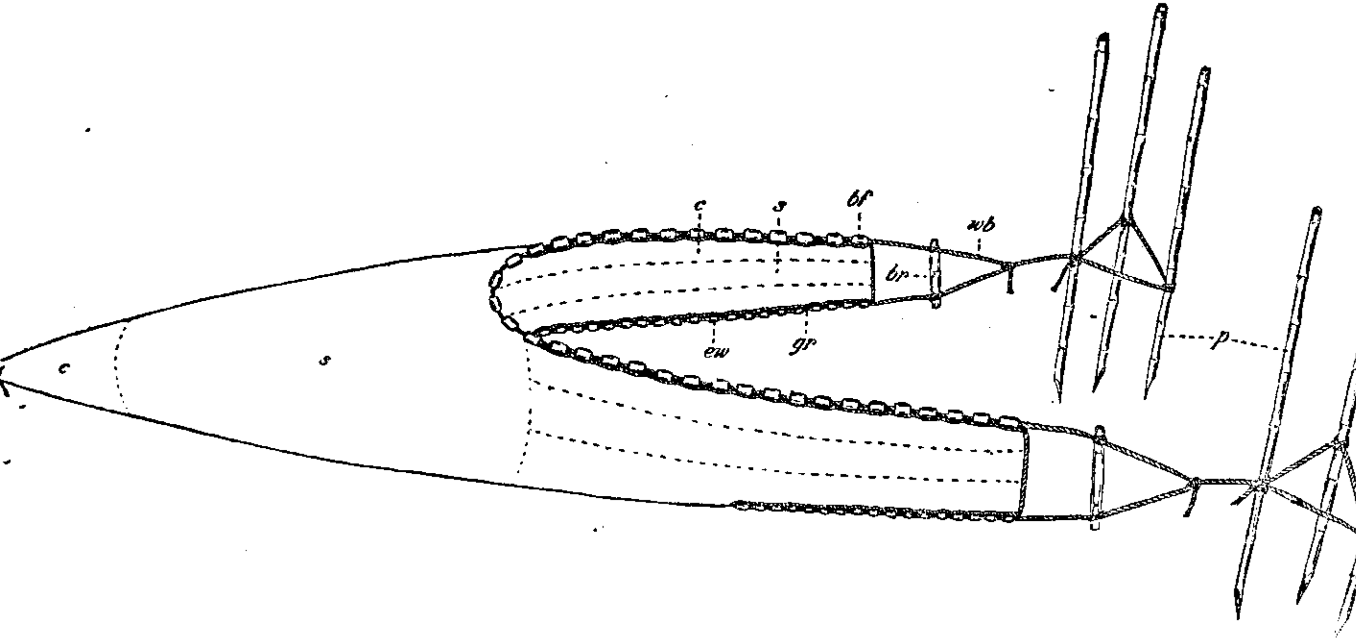
During the ipon season the catch of a single ipon outfit is sold to ipon dealers, and after each month of the season the money is divided among the members of the crew, the shares of each person being dependent upon the amount of his stock. Persons who help in the hauling of the nets are given a cup of ipon after each haul.

The *tangar* is a large baglike net of coarse cotton cloth and sinamay. The bag is about 7 meters long, and the wings 6 meters long and 2 meters wide at their widest portion and 1 meter wide at the ends. Text fig. 1 shows the parts and accessories of the terminal portion of the wing of a tangar. To the cork line of the tangar are attached wooden floats 3 inches long and 2 inches in diameter, at intervals of 1 foot. To the ground rope of the tangar are strung earthen sinkers 2 inches apart. The extensions of the free end of both the cork line and the ground rope form the wing bridle. To these wing bridles the bamboo brails are attached. The pull ropes are joined to the bights of the wing bridle.

The tangar net is operated on a gradually shelving sandy shore near the river mouth facing the incoming high tide. The pull ropes are attached to 6 bamboo poles driven firmly into the sandy bed of the beach. The tangar is set from half an hour to one hour when there is an abundant run of ipon. The string of the end of the main bag of the tangar is untied, and what is caught is emptied into a separate accessory bag of sinamay. The tangar is a very effective apparatus used in the catching of ipon in Ilocos Norte Province.

The *tuad* (text fig. 2) is a seine made of either sinamay cloth or coarse cotton cloth, 15 meters long and 2.5 meters wide at its widest portion, tapering towards the end of each wing where it is about 1.5 meters wide. Strung to the cork line at intervals of 2 inches are numerous wooden floats, each 2 inches long and 1 inch in diameter. To the bottom line are strung at intervals of 1 inch several bone or earthen sinkers, each 2 inches long and 1 inch in diameter. Unlike the daclis de ipon (chinchorro), the tuad has no bag. It can be operated from bamboo rafts by 10 to 15 persons along shallow beaches and along the banks at the mouth of rivers. The tuad is used extensively in Amburayan River, or in Bangar at Baroro River of Bacnotan, and in Bauang-Naguilian River.

The bobo, which is bottle-shaped and which may be of different sizes, is made of fine bamboo splints. The ordinary ipon bobo



1. Tangar, a small chinchorro net; perspective view. *c*, Cotton cloth of bobo and wings; *s*, sinamay part of wings and end bobo; *bf*, bamboo fl
wing bridle; *ew*, earthen weight; *gr*, ground rope; *br*, brail; *p*, bamboo pilings where pull ropes are attached. Ilocos Norte Province.

is about 80 centimeters long, the diameter of its mouth being 25 centimeters, and its posterior opening about 6 centimeters in diameter. The mouth of the bobo with a 4-hoop opening 25 centimeters wide is provided with a primary funnel about 20 centimeters long. Behind this primary funnel is a secondary inner funnel, 25 centimeters long, with a tube that has an opening 3 centimeters in diameter. The end tube of the inside funnel is in the same direction as that of the end neck of the bobo. When the bobo is used in the barricade traps the end neck is provided with a cloth stopper.

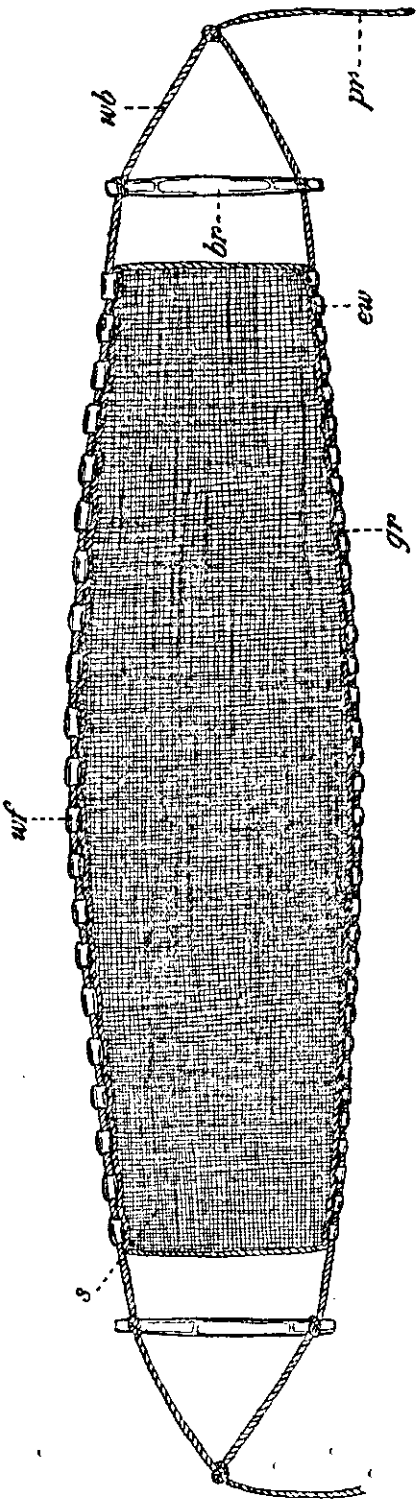
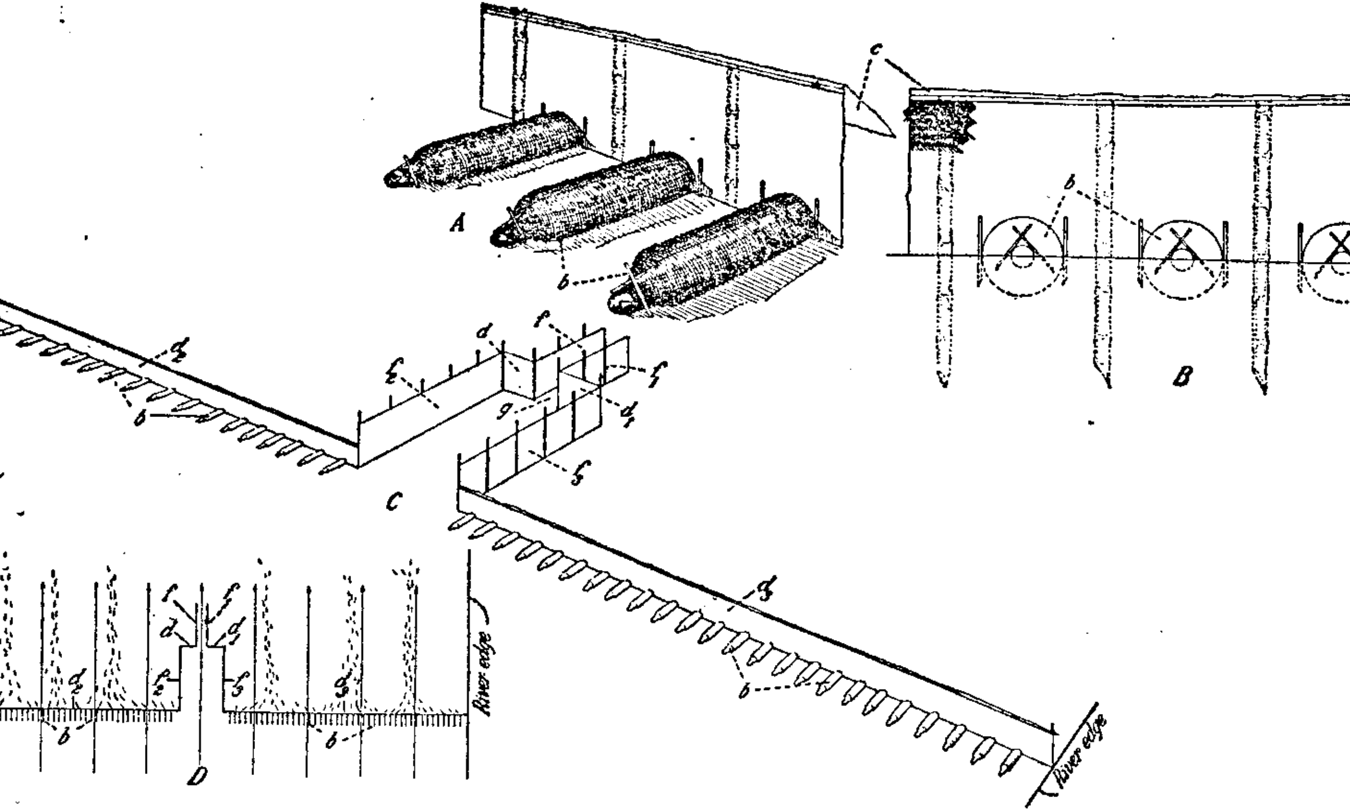


FIG. 2. Tuad net, diagrammatic. *wf*, Wooden float; *s*, sinamay; *br*, brail; *wb*, wing bridle; *cw*, earthen weight; *gr*, ground rope; *pr*, pull rope. La Union Province.

The pamoboan (*Plate 2, figs. 2 and 3, text fig. 3*).—In Laoag River, Ilocos Norte Province, the barricade ipon trap is known as pamoboan. The pamoboan is built in shallow water, from 2 to 4 feet deep. In text fig. 3, *f* and f_1 represent the primary head runners or parallel fences of the escapement, *padaoan;* these runners are from 5 to 12 meters apart, depending upon the width of the river. The walls which are attached to several bamboo pilings are regularly and firmly set in the river bottom. The runners, which are 2 meters high, are from 8 to



Pamoboan or pingi. *A*, Perspective view showing main parts; *B*, a section of a perspective view of a pamoboan showing how bobos are set in the and attached to d_2 or d_3, secondary barricade; *C*, *D*, plan views of pamoboan showing the accessory parts, direction of river current, and direction o gration against current. Laoag River. *b*, Bobo; *f*, f_1, primary runners of sawali; f_2, f_3, secondary runners of sawali; *d*, d_1, primary barricade of s d_3, secondary barricade of sawali; *g*, gate of escapement (padaoan).

10 meters long. The primary barricade of sawali is represented by d and d_1. It also is 2 meters high and is attached to several bamboo pilings on the upper ends of the parallel runners, f and f_1. These primary barricades are about 3 to 5 meters long. The secondary runners or parallel fences, which are attached to the left and right extreme ends of the barricades d and d_1, are represented by f_2 and f_3; these secondary runners are also 2 meters high and from 6 to 8 meters long. d and d_1 form the upper gate of the escapement, *padaoan*. d_2 and d_3 represent the secondary barricade of sawali, about 1 meter high and attached to bamboo pilings 2 feet apart. These secondary barricades of sawali and the row of bobos are placed below the sawali walls on the shallower portion of the river, extending to the left and right margins of the river. The bobos, which are placed a foot apart on a hollow river bed, are made to face downstream (text fig. 3, *C*). d_2 and d_3 are provided with strips of cotton cloth about 1 foot wide floating on the surface of the water above this sawali. The abrupt flow of the water above this strip of cloth is downward, creating a swift current. This cloth also protects the migration farther upstream. Unlike the swift current of the water towards the secondary barricades, the current at the escapement, *padaoan*, is not very swift, a condition that is unfavorable for the migration of the ipon. Every year there are from 10 to 18 pamoboans in operation in Laoag River. A pamoboan has 50 to 350 bobos.

The *pataya* (text fig. 4) is a simpler method of catching ipon in September, October, and November, when Laoag River is subject to floods. This device consists of the main barricade of cotton cloth set across either half or the entire width of a river. Behind the main barricade are several submerged runners, or fences of banana sheath.

The main barricade of cloth is attached to several bamboo stakes, 1 to 3 feet high, driven firmly in the river bed at intervals of 1 foot. A floating strip of cloth on top of the entire length of the barricade produces an abrupt flow of the water. The submerged low runners or fences of banana sheath which are about 1 foot away from the main barricade produce a swift current. Bobos are placed in between the runners facing the river current. A school of ipon migrating upstream retreat upon reaching the barricade cloth due to the abrupt flow of the water. The schools of ipon are then led between the runners

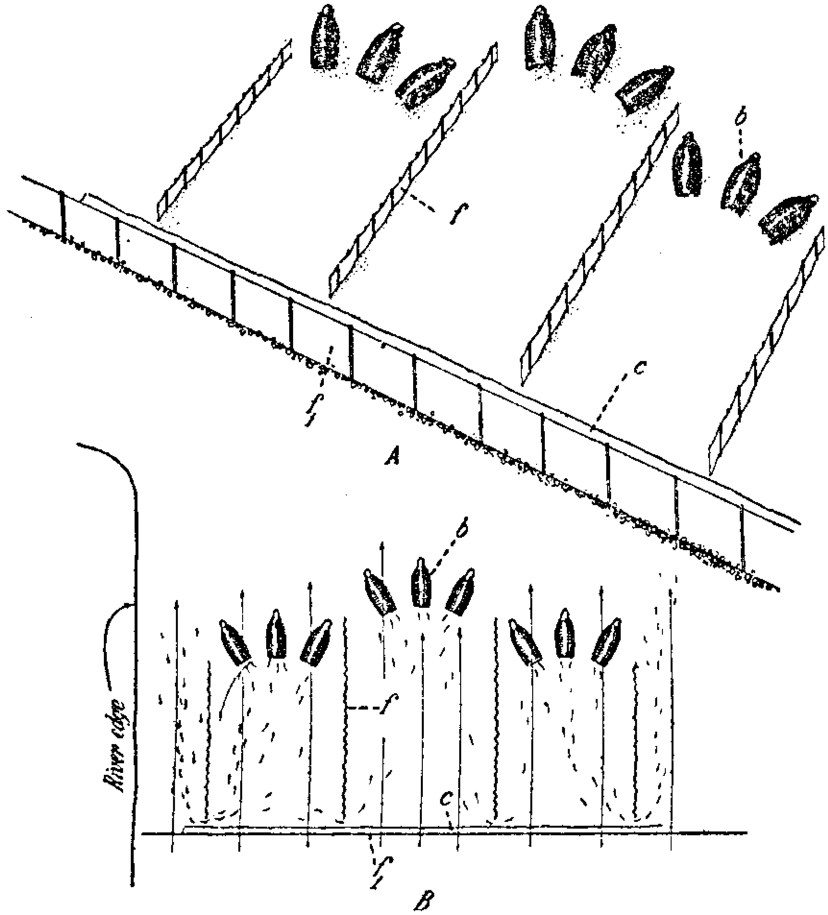


FIG. 4. *A*, Perspective view of a section of a pataya. *B*, Plan of a pataya showing accessory parts, direction of river current, and direction of ipon migration. Laoag River. *B*, Bobo; *f*, parallel runners of banana sheath; f_1, barricade wall of cotton cloth; *c*, bagaybay cotton cloth.

where the current is swift, finally to be entrapped into the bobos. This is an indirect method of catching ipon.

The *pasalugqui* (text fig. 5) consists of the main barricade of cloth and several low V-shaped submerged runners of banana sheath with the bobos set at the junction of the runners, facing the current of the river. This method is employed during the rainy season. The advantage of the barricade wall of cloth during the rainy months is that it sieves the mud carried away by the water, making the water clearer below the barricade and in between the runners where the water current is usually

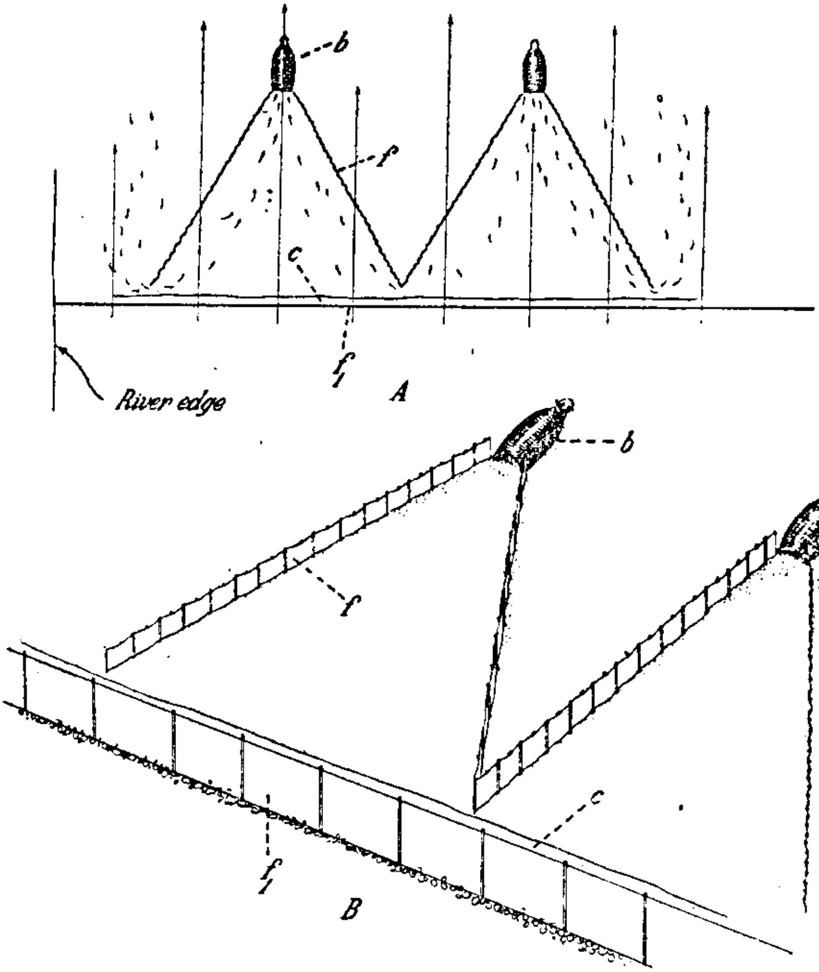


FIG. 5. *A*, Diagrammatic plan of a section of a pasalugqui; direction of river current and direction of ipon migration. *B*, Perspective view of a section of a pasalugqui showing parts. *b*, Bobo; *f*, banana sheath runners; f_1, barricade wall of cotton cloth; *c*, bagaybay cotton cloth. Laoag River.

swifter. The ipon are more active in clear water than in turbid water.

The lel-len (*text fig. 6*).—Along the margins of Laoag River, among the fresh-water algæ and the habitat of river snails, a very simple means of catching schools of ipon fry, called *tartarac*, is the lel-len. This gear consists of two parallel dams of pebbles and stones about 20 meters long and about 1.5 meters wide. Downstream towards the lower ends of the dams a matting of bamboo *akilis*, 2 feet long and 1 foot wide, faces the

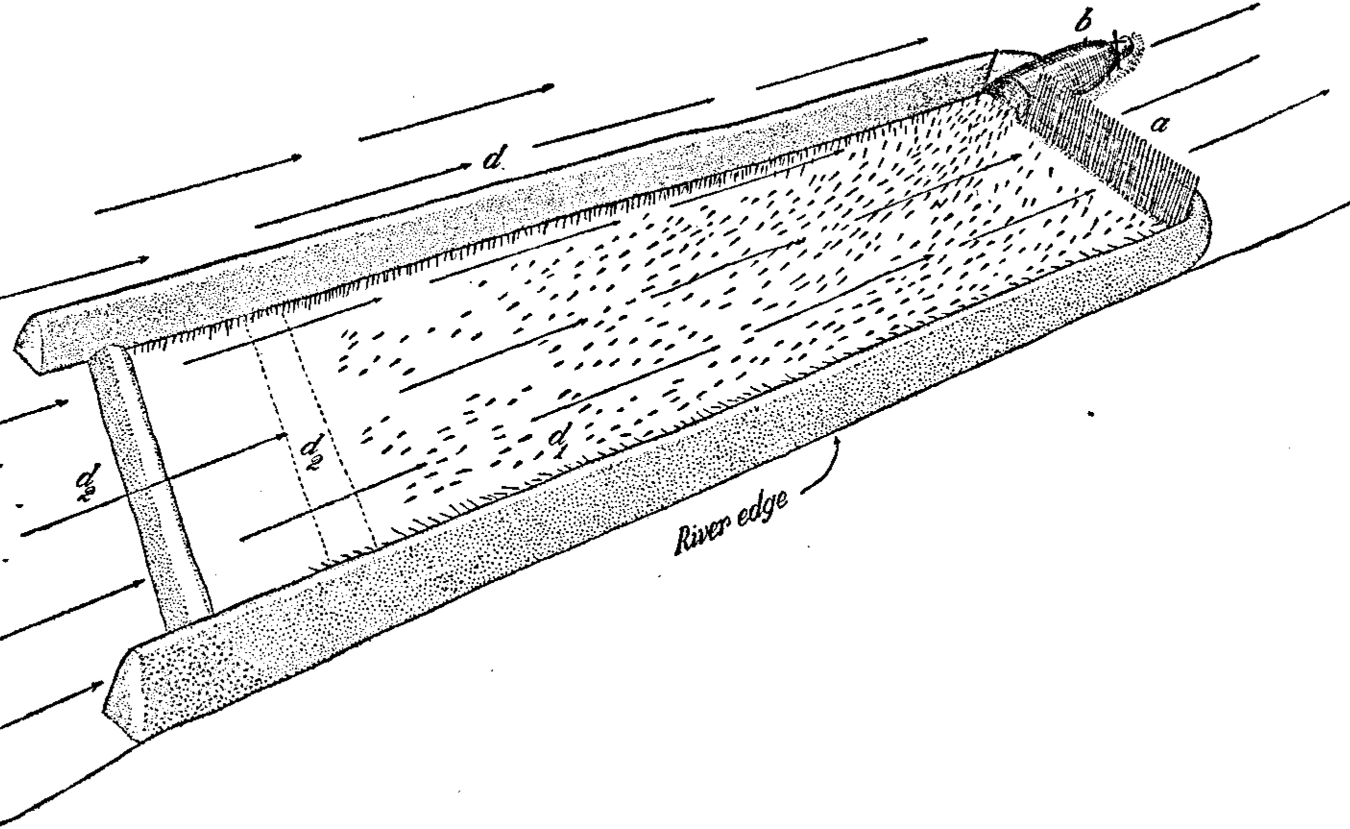


FIG. 6. Lel-len, diagrammatic. *a*, Bamboo screen (akilis); *b*, bobo; *d*, d_1, dams of sand; d_2, provisional dams of sand; direction of river current migration of ipon, Laoag River.

flow of the water. In addition to the main dams there is a provisional dam that is moved gradually downwards toward the bobo and akilis, driving the enclosed tartarac into the bobo. The lel-len is a very simple device used in catching ipon along the margins of rivers.

The *paed* (text fig. 7) is a device consisting of several inverted V-shaped bamboo stakes, barricaded with galvanized iron walls and sinamay hoop nets laid across the entire width of a swift, shallow gravelly stream or river. In text fig. 7, f represents the head fence of a single paed, which is a semicircular wall of galvanized iron attached to several bamboo stakes, 1.5 feet long, piled on gravel bottom. f, the head fence, has a radius of about 10 inches. f_1 and f_4 are barricade fences of galvanized iron 2 meters long on each side and about 1 foot high. f_2 and f_3 represent galvanized-iron parallel fences, 15 inches apart, each fence about 1.66 meters long and about 1 foot high. g and g_1 represent the gates of the barricade at the left and right sides, each being about 8 inches wide. n and n_1 represent sinamay hoop nets attached to bamboo stakes at the gates and at the ends of the parallel fences towards the head fence. These nets are about 1 meter long, with a diameter of about 1 foot. In both outer sides of fences f_1 and f_4 are shallow canals leading to the gates at the mouth of the nets. The current of the water between the parallel fences f_2 and f_3 downwards from semicircular fence f is feeble and not very swift, the direction of the current being toward the gates. The presence of the submerged runners f_1 to f_4 and the canals on their outer sides produces the swift current of water towards the gate. The ipon that migrate upstream in the paed are able to swim above the fences f_1 and f_4 and then are led into the mouth of the sinamay hoop nets.

Herre (1927) described the paed as a less permanently deadly device. He described it as merely a cloth fence strung across the river with bamboo fish traps placed in openings at intervals of 4 or 5 meters. Herre's description does not agree with the illustration given in text fig. 7. The paed, which consists of a row of bobos set across the entire width of a river, is as effective as the pamoboan. The barricade walls of the paed are permanently set across the entire width of the stream during the ipon season. Whenever ipon migrate upstream, these hoop nets are attached to the bamboo stakes of the gates of the paed.

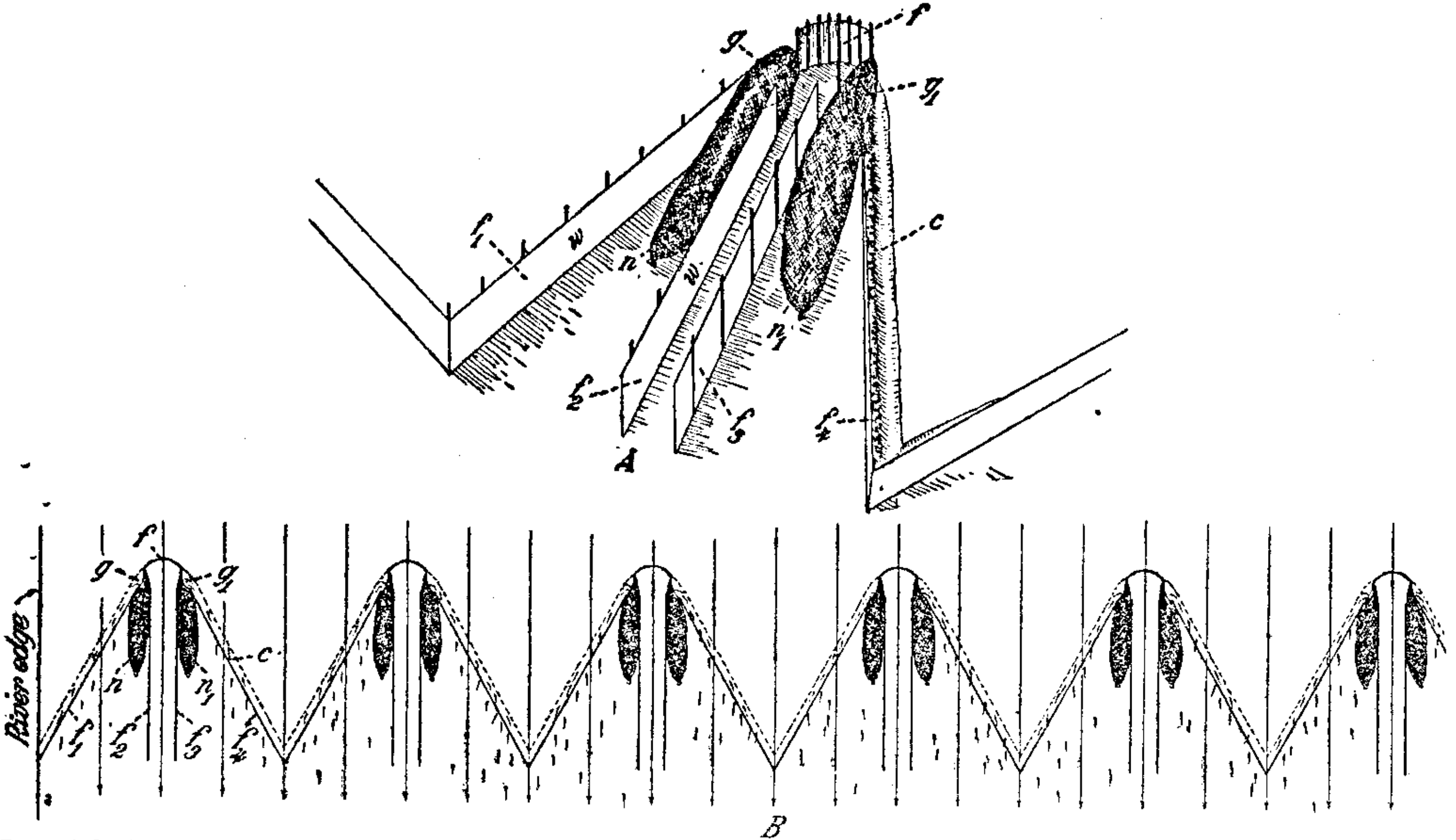


FIG. 7. *A*, Paed, perspective view. *B*, Diagrammatic sketch of a series of paed showing arrangement of runners, canals, hoop nets of sinamay, direction of river current, and migration of ipon. Bauang-Naguilian River. *c*, Canal leading into gate; *g*, g_1, gates; *n*, n_1, hoop nets of sinamay; *f*, semicircular barricade; f_1 to f_4, fences or runners; *w*, walls of runner, sawali or galvanized iron.

The *paayas* (text fig. 8) consists of a series of dams of pebbles and stones, 1 foot high, 1 foot wide, 15 meters long, and about 1 meter apart, built on the gravelly margin of a swift-flowing stream or river. At a distance of 10 meters from the head dams inverted V-shaped barricades of bamboo stakes with banana sheath walls are laid between the channels. At the opening intersection of each barricade a bobo with the mouth facing downstream is placed at each of the smaller openings of the diverging walls of the inverted V-shaped barricade. As the ipon migrate upstream along the margin of the stream, they find their way to the swift current of water between the parallel dams into the bobo.

The *caput* or dip net is a very handy device for catching ipon along the seashore and at the mouth of the river. One type of caput is a dip net of sinamay (text fig. 8) mounted on a triangular bamboo frame. Its mouth is about 1 meter on the sides, 1.5 meters at the base, and 0.5 meter on top. A fisherman operates the dip net by pushing it along the shallow beach and lifting it after the tide has receded.

Another type of *caput* (text fig. 9) consists of a conical sinamay bag about 1 meter long, its mouth having a diameter of 10 inches. It is attached to two small wooden or bamboo handles about 1 foot long.

The importance of the ipon fisheries.—The ipon fisheries of northern Luzon are undoubtedly among the most important fishing industries in the Philippines. A conservative estimate of their annual value is about 500,000 pesos. The time of fishing is about 15 days of each month from September to February of every year. A great number of people of the fishing villages are benefited by this seasonal industry.

Ipon is considered a delicacy by the people of northern Luzon. The catch is usually sold in the local markets fresh, salted, or as *bagoong*. Ipon can be prepared for food in several ways; such as pickle, *tamale*, and *sinigang*. Ipon pickle is prepared by adding ¼ cup vinegar to 1 cup of fresh ipon, seasoned with salt and pepper. Tamales are made by wrapping fresh ipon banana leaves and boiling them in water with about four tablespoonfuls of vinegar and a tablespoonful of salt. Sinigang is made by boiling one cup of fresh ipon in 1¼ cup water, with sliced green or ripe tomatoes. Ipon *bagoong* is prepared by adding two parts of salt to five parts fresh ipon or two parts of ipon to one part salt. The containers used are earthen jars

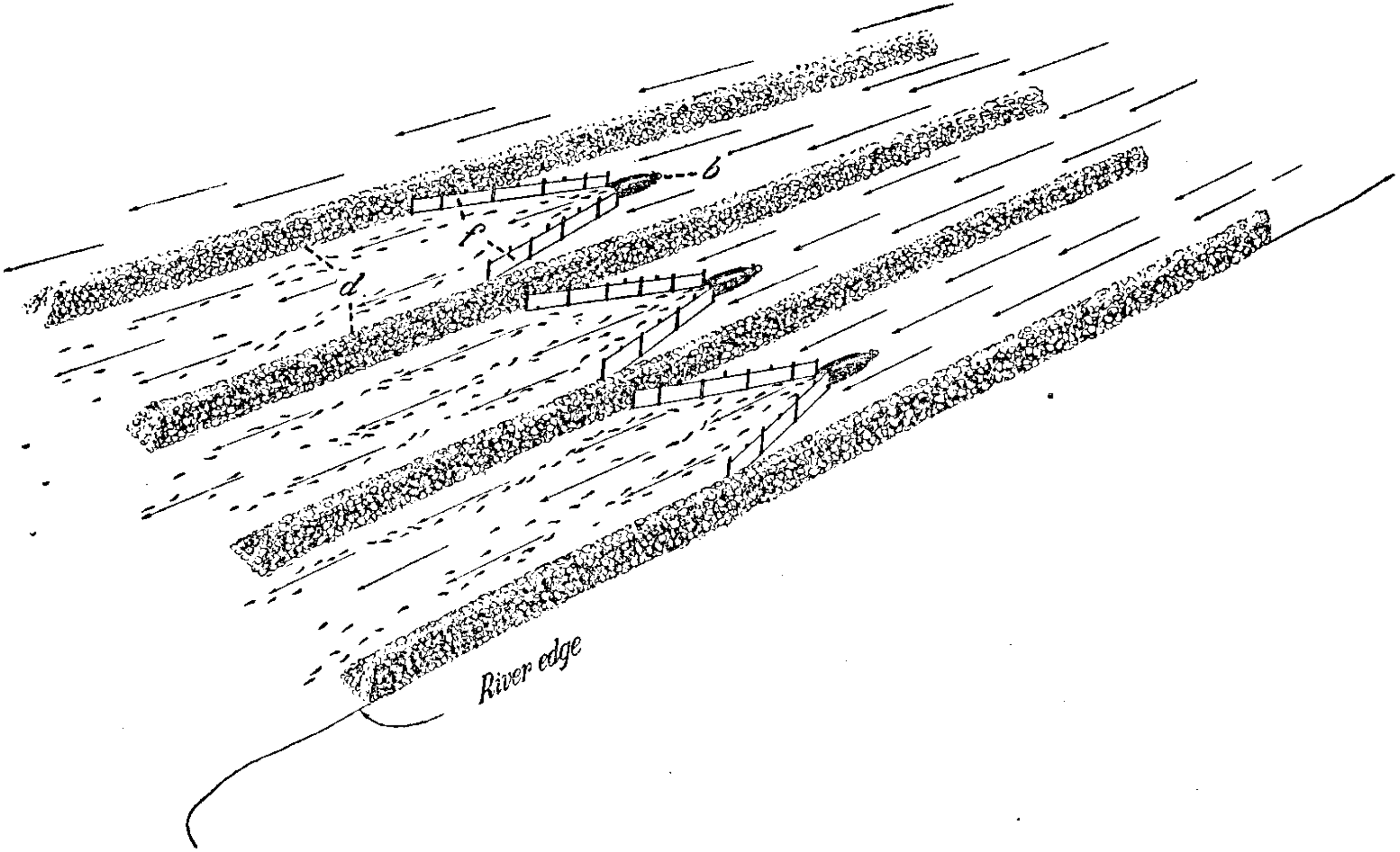


FIG. 8. Paayas, diagrammatic. *b*, Bobo; *f*, runners or fences of banana sheath; *d*, dams of stones. Bangar, La Union Province.

locally known as *burnay*. A burnay filled with salted ipon is then covered with a piece of clean cloth and then left to ferment for one to two months.

In Ilocos Norte Province, the ipon fisheries are commercially important along the shores of Gabu and La Paz, at the mouth of Laoag River, which is about 11 kilometers from the town. This river starts from several eastern streams, passing through the towns of Nueva Era, Banna, Solsona, and Piddig to form the main river flowing west through the towns of Dingras, Sarrat, and Laoag. In February, March, April, and May, the streams are shallow, narrow, and fairly rapid; but during the rainy season they are fed by the torrential rains from the Cordillera Mountains, and the main river becomes flooded. During floods the river is very swift, several meters deep, and less than a kilometer wide at its mouth.

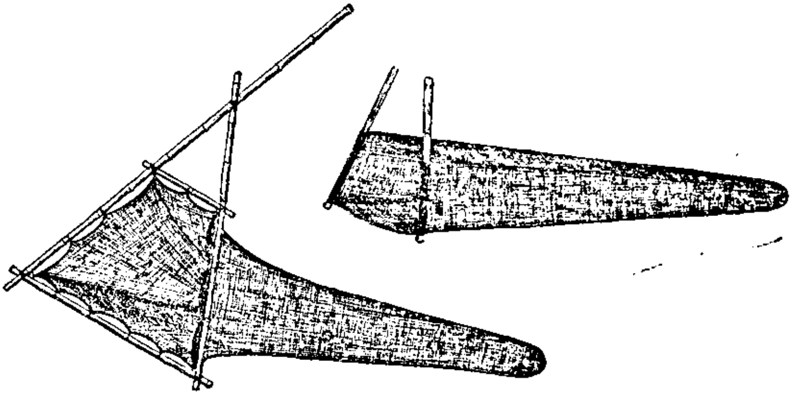


FIG. 9. Dip nets.

In November and December, 1934, and January, 1935, during the height of the ipon season the daily catches of ipon at La Paz Barrio, Laoag, and at Laoag River were recorded in order to determine the rate at which the fry were removed from the fishery by the various effective fishery devices. During the third run in November, 1,421 5-gallon cans of ipon, valued at 7,105 pesos, were caught in seven days; for the fourth run in December, 904 5-gallon cans of ipon, valued at 4,520 pesos, were caught in twelve days, and for the fifth run, 956 5-gallon cans of ipon, valued at 4,780 pesos, were caught in seven days.

During the third, fourth, and fifth "runs" of ipon at Gabu and La Paz Barrios, Laoag, a total of 4,370 5-gallon cans of ipon (82,702.25 liters) were caught. The total value of the ipon caught during these three "runs" amounted to 21,845 pesos. For the six "runs" of ipon for 1934 and 1935, the estimated value of 7,000 5-gallon cans of ipon caught amounted to 35,000 pesos.

There were fifteen registered chinchorro nets for the municipality of Laoag, and the fees collected for the first and fourth quarters of 1934 and 1935 amounted to 174 pesos. There were 2,068 bobos in 18 ipon traps at Laoag River. The fee for all the bobos used at Laoag totalled 277.70 pesos (15 centavos for each bobo at a first-class location and 10 centavos each for a second-class location).

Other fishing regions for ipon in Ilocos Norte Province are at Bangui Bay, Bacarra River, and Gaang and Gabot shores.

In Ilocos Sur Province the known ipon fishing grounds are at Santa and Caoayan shores, Santa-Abra River, Santa Cruz River, and Amburayan River at Tagudin.

Ipon is caught along the seacoasts, and at Amburayan-Baroro, Bauang-Naguilian, and Aringay Rivers of La Union Province.

In Cagayan Province ipon fishing is done at Abulug and Cagayan Rivers, and at Aparri and Buguey shores.

Recommendations.—Remedial and regulatory measures for the ipon fisheries of northern Luzon are recommended to insure the stability of the stock and the source of supply.

Definitions.—For the purpose of the proposed Administrative Order, ipon shall mean the fry or fingerlings of gobies found in Cagayan, Ilocos Norte, Ilocos Sur, La Union, and Zambales Provinces; traps shall include bobo, sarep, pataya, pamoboan, pingi, padait, paculud, pasalugqui, paed, burayoc, lel-len, and etter, and similar fishing traps and fishing devices.

Restrictions.—(*a*) No bobo traps shall be constructed within 200 meters from the mouth of any river system, and the intervals between them shall be no less than 200 meters; (*b*) ipon traps shall be so constructed as to leave open the middle third of the width of a river or stream to allow ipon or other fishes free passage during their migration upstream or downstream.

Prohibitions.—It shall be unlawful for any person, association, or corporation to use (*a*) bobo or other similar devices in catching ipon from January to March 31 of each year; (*b*) no sarep, paculud, cascasad, sacsaclang, pasarsur, and kitang shall be used from April 1 to May 31 of each year; (*c*) ipon nets, like chinchorro, tangar, garamgam, and tuad shall be used only along the shores below 100 meters on both sides of the mouth of a river from January 1 to March 31, and from September 1 to December 31 of each year.

The advantages of the restrictions on the use of bobo traps (paed, pingi, pasalugqui, paculud, paayas, pamoboan, pamalibotocan, burayoc, etter, and others) are (*a*) there will be a reduction in the number of bobos in the series of traps if the middle third of the width of the river is free; (*b*) there will be a greater proportion of escapement if the traps are 200 meters apart; (*c*) the people upstream will be benefited, because there will be less chance of the ipon being caught downstream; (*d*) escapement upstream will be enough to keep up the balance of stock that should reach sexual maturity.

The advantages of the prohibitions are (*a*) the prohibition of the use of the bobo in January, one month during the height of the ipon season up to February and March when the season is at its ebb, insures a greater stability of escapement to keep up the balance of stock; (*b*) protection of the maturing gobies that are still migrating in April and May; (*c*) avoidance of the obstructions to the trend of migration of the ipon along the shore 100 meters distance from each side of the mouths of rivers; (*d*) allowing the people upstream the benefit of catching a greater number of adult gobies in June, July, and August.

However, there are some objections of fishermen to the restrictions and prohibitions proposed. Fishermen who employ bobo traps claim that their catch in October, November, and December is very much reduced by the opening of the middle third of their series of traps and the greater distance between traps. On the other hand, these restrictions have been recommended primarily to put an end to controversies between people upstream and downstream by giving the residents upstream a chance to catch ipon; and secondarily, to set free a reasonable number of the fry to reach upstream in order to keep up the balance of stock.

Another serious objection of fishermen to the prohibition of the use of chinchorro net below 100 meters on both sides of the mouth of a river is that they are unable to catch ipon at the mouth of a river, where the catch is supposedly great. Others claim that some rivers have very rough shores where they are unable to use their boats and ipon nets. However, this prohibition is recommended to rehabilitate the river systems. If the trend of migration of the ipon is disturbed due to the use of several boats and nets at the mouths of rivers, the chance of the ipon to enter the river is reduced, and the ipon are either caught or carried away by the waves.

The effectiveness of the restrictions and prohibitions in increasing the stock can be determined by actual trial and careful observation of the result. Administrative Order No. 6, series 1924, should be amended to relieve the present economic difficulties in the upper towns of the river systems of the Iloko regions.

SIGANID-FRY FISHERY

The fry of the species of the genus *Amphacanthus*, of the family Amphacanthidæ, are known as *padas* and *yomoyobyob* (Ilk.), *padas* (Pang.), *kuing* (Bicol), and *kuyog* (Vis.). The adults of these fry are known as *barangan* and *malaga* (Ilk.), *batawayi* and *turus* (Bikol), *danguit, mandalada, layap,* and *tayog* (Vis.), *belony* and *indogan* (Tao, Sug., and Samal) and *samaral* (Tag.).

The members of the family Amphacanthidæ are small to moderate-sized fishes, reaching a maximum length of 40 centimeters. They are herbivorous fishes inhabiting submerged coral reefs. Some are brilliant or dull in color. As a group they are excellent sources of protein food. The fry when they appear in schools are generally 1 to 3 centimeters long.

Fishing grounds and seasonal occurrence.—The important regions where the siganid-fry fisheries are located are on the coral reefs of Puro, San Vicente, Gonzaga, Buguey, and Claveria Municipalities, Cagayan Province; Palanan Bay, Isabela Province; Bobon Barrio, and Buraan Sitio, Burgos Municipality; Davila Barrio, Pasuquin Municipality; Gaang, Currimao Municipality; Gabot, Badoc Municipality; Ilocos Norte Province: Pugos Barrio, Sinait Municipality; Pugus, Cabugao Municipality; Puro Pingit, Magsingal Municipality; Santa Maria, San Esteban, Santiago, and Narvacan Municipalities, Ilocos Sur Province: Lingayen Gulf, Pangasinan Province: western coast of Zambales Province: Camarines, Sorsogon, Bohol, Cebu, and Surigao Provinces, and the Sulu group.

The catching of siganid fry varies throughout the Philippines. For instance on the northern and northwestern coast of Luzon, siganid fry are caught from August to September and from March to May. In the Visayas, they are taken in great quantities from Tagbilaran, Bohol, from May to June, since the spawning activity of the adult siganids is from January to February. (Manacop, 1936).

Methods of catching siganid fry.—Siganid fry are caught with fine-meshed chinchorro nets called *kamang* or *tangar* on the northern and northwestern coast of Luzon. In the Visayas siganid fry and eggs are caught in the pounds of the fish corrals.

Throughout the Philippines the practice of catching breeding siganids with baclad, tangar, gill nets, and spear guns, and siganid fry with baclads and fine-meshed chinchorros, is a factor of depletion of the siganid-fry fishery. Siganid fry may appear abundantly in one year and not at all in the next two years.

Importance of siganid-fry fishery.—There are no records of the annual catch of fry throughout the Philippines as a whole. The scarcity of adult siganids and the absence of padas in northwestern Luzon in 1935 and 1936 are an alarming indication of the depletion of the siganid-fry resources of that region.

Siganid fry caught are made into bagoong or *guinamos*, a delicacy much liked by the people of Luzon. Dañgit eggs that are gathered from the pounds of the fish corrals of Bantayan, Cebu, are also salted in the proportion of three to four gantas of salt to one 5-gallon can of dañgit eggs.

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ILLUSTRATIONS

PLATE 1

FIG. 1. A saplar for catching bañgos fry at the mouth of the Bobon-Buraan tidal creek, Burgos, Ilocos Norte Province.

2. Segregating the bañgos fry from other larval fishes and transferring the bañgos fry in the palayok.

3. Catching bañgos fry with sagap at the marine shores of Bobon-Buraan, Burgos, Ilocos Norte Province.

PLATE 2

FIG. 1. Setting the bobos in the pamoboan, Laoag River.

2. Removing bobos from the pamoboan, Laoag River.

3. Removing the catch of ipon from the bobos.

TEXT FIGURES

FIG. 1. Tangar, a small chinchorro net; perspective view. *c*, Cotton cloth of bobo and wings; *s*, sinamay part of wings and end bobo; *bf*, bamboo float; *wb*, wing bridle; *ew*, earthen weight; *gr*, ground rope; *br*, brail; *p*, bamboo pilings where pull ropes are attached. Ilocos Norte Province.

2. Tuad net, diagrammatic. *wf*, Wooden float; *s*, sinamay; *br*, brail; *wb*, wing bridle; *ew*, earthen weight; *gr*, ground rope; *pr*, pull rope. La Union Province.

3. Pamoboan or pingi. *A*, Perspective view showing main parts; *B*, a section of a perspective view of a pamoboan showing how bobos are set in the river bed and attached to d_2 or d_3, secondary barricade; *C*, *D*, plan views of pamoboan showing the accessory parts, direction of river current, and direction of ipon migration against current. Laoag River. *b*, Bobo; f, f_1, primary runners of sawali; f_2, f_3, secondary runners of sawali; d, d_1, primary barricade of sawali; d_2, d_3, secondary barricade of sawali; *g*, gate of escapement (padaoan).

4. *A*, Perspective view of a section of a pataya. *B*, Plan of a pataya showing accessory parts, direction of river current, and direction of ipon migration. Laoag River. *b*, Bobo; *f*, parallel runners of banana sheath; f_1, barricade wall of cotton cloth; *c*, bagaybay cotton cloth.

5. *A*, Diagrammatic plan of a section of a pasalugqui; direction of river current and direction of ipon migration. *B*, Perspective view of a section of a pasalugqui showing parts. *b*, Bobo; *f*, banana sheath runners; f_1, barricade wall of cotton cloth; *c*, bagaybay cotton cloth. Laoag River.

FIG. 6. Lel-len, diagrammatic. *a*, Bamboo screen (akilis); *b*, bobo; *d*, d_1, dams of sand; d_2, provisional dams of sand; direction of river current and migration of ipon. Laoag River.

7. *A*, Paed, perspective view. *B*, Diagrammatic sketch of a series of paed showing arrangement of runners, canals, hoop nets of sinamay, direction of river current, and migration of ipon. Bauang-Naguilian River. *c*, Canal leading into gate; *g*, g_1, gates; *n*, n_1, hoop nets of sinamay; *f*, semicircular barricade; f_1 to f_4, fences or runners; *w*, walls of runner, sawali or galvanized iron.

8. Paayas, diagrammatic. *b*, Bobo; *f*, runners or fences of banana sheath; *d*, dams of stones. Bangar, La Union Province.

9. Dip nets.

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PLATE 1.

PLATE 2.

NOTES ON RECENT COLLECTIONS OF BIRDS FROM PALAWAN AND BUSUANGA

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ONE PLATE

The peculiarity of the fauna and flora of Palawan Island seems to have attracted many naturalists despite difficulties of transportation.

J. B. Steere,(16) of the University of Michigan, was the first bird collector to visit Palawan. He was in Puerto Princesa in July, 1874, and there collected specimens of 31 species, 10 of which were new to science.

Three years later, A. H. Everett, an English naturalist, spent December and parts of November and January in Puerto Princesa. According to Tweeddale,(17) Everett collected specimens of 52 species, 9 of which were new to science, and 32 had not been collected by Steere.

On the basis of his observations Everett(5) published comments on the zoögeographical relationship of Palawan.

Doctor and Mrs. Platen visited Puerto Princesa in the summer of 1887. According to Blasius,(3) who published the results of their collections, specimens of 130 species were obtained on this trip, 8 of which were new.

Sharpe(15) writes that E. Lempriere collected 31 species from Palawan.

In 1887 John Whitehead spent four months (probably July to October) at Taguso on the southeast coast, several kilometers south of Puerto Princesa. According to Sharpe,(15) Whitehead obtained 129 species, 8 of which are described as new. Whitehead(18) himself published his field notes of Palawan and enumerated all the species known from the island.

The members of the Steere Expedition were in "Paragua" (= Palawan) in August and September, 1887, according to Steere.(16)

F. S. Bourns and D. C. Worcester, who were members of the Steere Expedition to the Philippines in 1885–1888, returned to

Palawan in January, 1892, with the Menage Scientific Expedition. Accounts of their travels were published in Washington in 1898.(19)

R. C. McGregor collected in Palawan in December, 1901, and obtained a few bird specimens from Puerto Princesa(8) for the Bureau of Science. He again visited Malampaya Sound and Ulugan Bay in September, 1910. In 1925 McGregor again visited Puerto Princesa, making short trips to Iwahig Penal Colony and other nearby places. Accompanied by his three assistants in the Bureau of Science, McGregor stayed in Palawan Island from August to November, 1925. The birds obtained in 1925, however, were mostly sent to foreign institutions. Those retained in the Bureau of Science form a part of the basis of this paper.

A. Celestino and M. Canton, of the Bureau of Science, made collections in Puerto Princesa and Tinabog in December, 1905, and January and February, 1906. The results of that collection were published by McGregor.(9)

E. A. Mearns(11) added *Butorides spodiogaster*, which he shot near Malampaya Sound, to the list of Palawan birds.

As superintendent of the Iwahig Penal Colony from September 1, 1906, to February 4, 1908, John R. White collected several hundred specimens, which for some time were deposited in the Bureau of Science. McGregor made use of this collection temporarily in his care by taking notes for his Manual of Philippine birds.(10) The collection was later sold to the American Museum of Natural History in New York.

On the invitation of Colonel White, W. P. Lowe, an English naturalist, visited Palawan in June and July, 1907. With the help of Colonel White and the prisoners, Lowe(6) collected specimens belonging to 82 species.

John T. Zimmer, who was formerly in the employ of the Philippine government, collected birds in Palawan in March and April, 1906. He(20) enumerated 93 species, 60 of which were represented by specimens.

Between 1911 and 1927 W. Cameron Forbes collected birds in several parts of the Archipelago. He was occasionally assisted in his field activities by D. C. Worcester, R. C. McGregor, and A. Celestino. The birds, some of which were obtained from Palawan, were later turned over to the Museum of Comparative Zoölogy at Harvard University, and formed part of the basis of Bang's(1) publications.

I was informed that Mr. W. Parsons, of Manila, collects birds in Palawan from time to time, and that he sends his birds to London. Unfortunately I have not come across a publication describing his collection.

Mr. Graciano Castañeda, an officer in the Revenue Cutter "Arayat," collects birds whenever opportunity offers. He has collected a few specimens from Palawan and adjacent islands. Some of them are kept in the Collection of the Bureau of Science.

In April, 1936, F. Rivera and I spent 16 days in Bacuit and vicinity in northwestern Palawan, where we gathered data on the edible birds' nest industry. On this occasion collecting was done whenever convenient.

M. Celestino spent November, 1934, in Palawan and November and December, 1936, in Cuyo and Busuanga to enforce the fish and game law, and at this time was able to do a limited amount of collecting.

This paper is based on the birds collected by R. C. McGregor and party, by M. Celestino, and by F. Rivera and me; the specimens are now in the Collection of Birds of the Bureau of Science. The quoted field notes are from unpublished data of R. C. McGregor and were secured in Puerto Princesa; the others were taken by me.

GENERAL ECOLOGY OF NORTHWESTERN PALAWAN

In a previous paper(7) I partly indicated the general conditions of the rocks and caves in Bacuit and neighboring islands. Close to the rocky cliffs, swifts and swallows are plentiful, particularly during early morning and late afternoon. It should be noted, however, that the locality has varying ecological conditions. The topography is generally rugged. There are large areas of virgin forest, inspite of the fact that logging and clearing have been going on for many years. As a result of the activities of man, there are many second-growth forests and "kaiñgins"[1] adjoining virgin forests. On the dark debris-covered floor of the virgin forest may be noted occasional cleared circular areas, about 1 meter in diameter, which, according to the natives, are prepared by the male Palawan peacock pheasant during courtship (Plate 1). Scratches on the ground are the only indication of areas prepared by the Palawan peacock pheasant. Whitehead, according to Beebe,(2) considers these areas "showing off" arenas, but Beebe disagrees with Whitehead

[1] Cultivated areas on hillsides.

and seems to doubt the assertion that they were made by the peacock pheasant. Weird call notes of imperial pigeons, *Ducula ænea palawanensis*, may be heard from the tops of tall trees, where these birds cannot be seen on account of the thick foliage. In second growth and in kaiñgins the jungle fowl are seen and heard at any time of the day, but particularly at dawn and sundown. Many other species of birds occur in this type of environment. Coconut groves characterize most of the clear areas along the shore. Sunbirds, flowerpeckers, and doves may be seen in these places. In a number of tidal creeks and mangrove swamps along the shore, kingfishers, shore birds, and occasional sunbirds are characteristic bird life.

BIRDS RECENTLY COLLECTED FROM PALAWAN

MEGAPODIIDÆ

MEGAPODIUS NICOBARIENSIS CUMINGII Dillwyn. Palawan megapode.

One female, *Manuel and Rivera.*

The specimen was obtained while crossing a path in a thick brush. Natives of nearby islands informed me that on many islets in the Sulu Sea hundreds of megapodes come in April, May, June, and July to lay their eggs and leave for the mainland soon after the eggs have been laid. The inhabitants of the mainland, who are obviously familiar with the habits of this bird, then come in vintas,[2] and after a few days leave the islets with their vintas loaded with megapode eggs. This report is partly corroborated by G. Alcasid who with G. Maceda, both of the Bureau of Science, spent April and May, 1938, in Palawan. According to the former, they obtained a chick and four eggs from a mound in Stanley Island, in Green Island Bay, May 8. They found later that May 9 more than 30 eggs were obtained from the same mound by the moros. Their unfamiliarity with the habits of the bird and the nature of the mound were alleged to be the causes of their not getting all the eggs on May 8.

PHASIANIDÆ

GALLUS GALLUS GALLUS (Linn.). Red jungle fowl.

Two females, *McGregor;* 3 males and 2 females, *Manuel and Rivera.*

Crowing roosters were often heard on the hills during early morning. In the afternoon the birds were seen, generally in pairs, feeding in clear areas along the edge of second growth, and on disturbance immediately seeking cover. The species appears common in many places in Palawan.

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[2] Small native dugouts.

POLYPLECTRON EMPHANUM Temm. Palawan peacock pheasant.

Two males, *Manuel Celestino.*

In a foregoing paragraph was mentioned a cleared circular patch attributed to the Palawan peacock pheasant. The natives claim that this bird is very seldom seen by man in the forest, and that nearly all birds caught were snared. The specimens added to the Bureau of Science Collection of Birds in recent years were all trapped, and were kept in captivity for some time.

TURNICIDÆ

TURNIX SUSCITATOR FASCIATA (Temm.). Philippine button quail.

One male, *Manuel and Rivera.*

"Fully developed eggs were found in the ovary of the females." Comparing these with specimens from Luzon, McGregor observed the female birds from Luzon with the black of the fore breast heavier and the chestnut collar much wider. He says "If these characters and the slight difference in size are constant, they would justify the recognition of *T. haynaldi.*" Unfortunately not one of the birds he collected is available, and the lone male bird we secured does not show any difference from the Luzon bird.

COLUMBIDÆ

TRERON CURVIROSTRA ERIMACRA Oberholser. Palawan thick-billed green pigeon.

Nine males and 2 females, *McGregor;* 1 male, *Manuel and Rivera.*

In Puerto Princesa, McGregor notes, "abundant, in flocks—feeding in fruit trees. 200 to 300 feeding in a tall balete (*Ficus* sp.) in clearing near forest. When disturbed, bunches of 10–50 fly over. Almost impossible to see in the trees." In Bacuit small flocks of from 2 to about 20 birds were noted feeding in fruit trees, occasionally with one or two imperial pigeons, *Ducula ænea palawanensis.* They were also seen feeding on grape-like berries growing on a vine, *Columella* sp.

TRERON VERNANS VERNANS (Linn.). Pink-necked green pigeon.

Six males and 8 females, *Manuel and Rivera;* 1 male and 1 female, *Manuel Celestino.*

Like the thick-billed green pigeon, the pink-necked green pigeon was observed to form small flocks in the vicinity of Bacuit. These birds were generally seen on fruit trees of second-growth forest and on edges of cleared areas.

DUCULA AENEA PALAWANENSIS (Blasius). Palawan imperial pigeon.

Two males and 6 females, *McGregor;* 1 male, *Manuel Celestino;* 2 males, *Manuel and Rivera.*

Common, but not abundant in northwestern Palawan. Noticeable only by its weird note uttered from tall trees. McGregor notes, "not abundant—few seen at any time in tall trees in clearings. Parties of 4–8 flying over."

STREPTOPELIA BITORQUATA DUSSUMIERI (Temm.). Island turtle dove.

Two males and 1 female, *Manuel and Rivera.*

In the vicinity of Bacuit this bird was generally seen in pairs about clearings on hillside and in coconut groves. McGregor notes, "at times glides with wings outstretched and resembles a cuckoo or a small hawk."

STREPTOPELIA CHINENSIS PALAWANA Hachisuka. Palawan spotted dove.

Three males and 2 females, *Manuel and Rivera.*

The general habits are similar to those of *S. b. dussumieri,* although this bird is more often observed in coconut groves.

CHALCOPHAPS INDICA INDICA (Linn.). Emerald dove.

One female, *McGregor.*

In Puerto Princesa McGregor saw a nest of this bird with two eggs. In this connection he notes, "about 2.5 meters from the ground on horizontal limb of a small tree with a tangle of vines around. Nest directly over edge of water at high tide. Very close to town on bay side."

LARIDÆ

THALASSEUS BERGII CRISTATUS (Stephens). Large crested tern.

One male, *Manuel Celestino.*

GELOCHELIDON NILOTICA NILOTICA (Gmelin). Gull-billed tern.

One male, *McGregor.*

CHARADRIIDÆ

CHARADRIUS LESCHENAULTII Lesson. Large sand plover.

One male, *Manuel and Rivera.*

SCOLOPACIDÆ

ACTITIS HYPOLEUCOS (Linn.). Common sand piper.

Two males and 3 females, *Manuel and Rivera.*

These birds were feeding along the beach in Bacuit.

NUMENIUS PHÆOPUS VARIEGATUS (Scopoli). Eastern whimbrel.

Three females, *McGregor;* 1 female, *Manuel Celestino.*

ARDEIDÆ

BUTORIDES STRIATUS JAVANICUS (Horsfield). Javan green heron.

One male, *Manuel and Rivera.*

Rare in mangrove swamps.

DEMIGRETTA SACRA (Gmelin). Blue-reef heron.

One female, *McGregor.*

A female bird was taken by McGregor's party from Puerto Princesa October 16, 1925.

GORSACHIUS MELANOLOPHUS RUFOLINEATUS Hachisuka. Malay bittern.

One male, *McGregor.*

McGregor records, "Iris clear dull green yellow—skin in front of eye lumiere green, duller behind eye, greener on side of ramus (bill light green)."

FALCONIDÆ

ACCIPITER TRIVIRGATUS TRIVIRGATUS (Temm.). Crested goshawk.

Two males and 1 female, *McGregor.*

For some time the identity of this bird remained unconfirmed. McGregor notes, "doubtful, but perhaps this species." Comparing these specimens with others from other places justifies the identification.

STRIGIDÆ

STRIX SELOPUTO WIEPKENI Blasius. Palawan wood owl.

One male, *McGregor.*

NINOX SCUTULATA SCUTULATA (Raffles). Japanese hawk owl.

Two males, *McGregor.*

Of one specimen which he identified as *Ninox japonica,* B.Sc. 7958, McGregor notes

> Similar to two specimens from Japan although the upper parts are darker gray in the Palawan skin. Several owls from other parts of the Archipelago that I have called *Ninox japonica* seem to have much more white on the underparts and the upper parts more rusty brown than do other specimens. It seems probable that the Palawan skin represents *N. japonica* and that the Philippine specimen should be called something else.

Measurements.—Wing, 225 mm; tail, 121; culmen from nostril, 13; tarsus, 23.

NINOX SCUTULATA BORNEENSIS (Bonaparte). Bornean hawk owl.

One male, *McGregor.*

A small owl which McGregor labelled *Ninox scutulata.* In general appearance it resembles *N. s. scutulata* but is smaller. In the absence of material for comparison, the bird is tentatively included in the Bornean race. This and the preceding race, *N. s. japonica,* are probably stragglers to this locality. According to Blasius (1888), a previous Palawan record of this race was made by Platen.

Measurements.—Wing, 225 mm; tail, 121; culmen from nostril, 13; tarsus, 23.

PSITTACIDÆ

PRIONITURUS DISCURUS PLATENÆ Blasius. Blue racket-tailed parrakeet.

Five males and 7 females, *McGregor;* 1 male, *Manuel and Rivera.*

Many birds congregate on tops of tall trees in cleared areas and on hills in the vicinity of Bacuit. They are noisy and very mobile. McGregor notes, "probably racket feathers of first year have narrow webs—new feathers on many specimens are already with bare shaft before far beyond the short feathers."

TANYGNATHUS LUCIONENSIS LUCIONENSIS (Linn.). Philippine green parrot.

One male, *Manuel and Rivera.*

Few birds were noted in Bacuit. A pair was seen coming out of a hole in the trunk of a tall tree on the hill.

CORACIIDÆ

EURYSTOMUS ORIENTALIS ORIENTALIS (Linn.). Broad-billed roller.

Two males, *Manuel and Rivera.*

Not very common in northwestern Palawan. Generally seen on cleared areas near the hills.

ALCEDINIDÆ

CEYX RUFIDORSUS Strickland. Red-backed three-toed kingfisher.

One female, *McGregor.*

McGregor notes, "In forest on low branch—sometimes edge of small pools in forest. Sits still and takes flight readily—when it flies away it utters a faint note."

RAMPHALCYON CAPENSIS GOULDI Sharpe. Palawan stork-billed kingfisher.

One male, *Manuel and Rivera.*

Two birds were noted by a river near Bancalen. Uttering its characteristic harsh notes the bird is seen on the wing moving swiftly from perch to perch.

ALCEDO ATTHIS BENGALENSIS Gmelin. Asiatic kingfisher.

One female, *Manuel and Rivera.*

Usually conspicuous over a stream watching for prey.

HALCYON CHLORIS COLLARIS (Scopoli). Philippine white-collared kingfisher.

One male, *McGregor;* 2 males and 2 females, *Manuel and Rivera.*

Common in mangrove swamps, where it makes a lot of noise.

BUCEROTIDÆ

GYMNOLÆMUS LEMPRIERI (Sharpe). Palawan hornbill.

Six males and 2 females, *McGregor.*

Iris dark Brazil red bill chalky white distal lower part of crest overhung mahogany red base of lower mandible black skin around eye and throat pallid methyl blue, becoming dusky on chin—legs and feet and nails blackish brown, the legs slightly steel blue.

CAPRIMULGIDÆ

CAPRIMULGUS MACRURUS SALVADORI Sharpe. Palawan long-tailed nightjar.

Three males and 1 female, *McGregor;* 1 male, *Manuel and Rivera.*

The peculiar note of this nightjar, resembling the note produced by chopping wood in the forest, was often heard at night and at dawn. In Bacuit the bird is called *patul-tul,* from its note. McGregor notes:

> First seen near our camp flying from mangrove over grassy area to forest. Could never find them in the mangrove though they seemed to come from there. Easily killed for they fly slow, fairly straight and high enough to be seen. As they fell in short grass, there was no danger of loss.
>
> Occasionally, they flew too low to be seen until near at hand and thus almost impossible to shoot. One evening I was surprised to see one light on the grass within 10 meters of me and twice I saw one on top of a telephone pole.
>
> Seen only for about a half hour at late dusk on moonless evenings. Not heard to call. Three to six usually went over within sight of one place.

MICROPODIDÆ

COLLOCALIA FUCIPHAGA AMELIS Oberholser. Whitehead's swiftlet.

One male and 1 female, *McGregor.*

McGregor observes:

> Abundant near our camp, feeding over grass, clearings, rice fields and roads through forest. During rainy and windy weather it flew very low and could be easily shot. On two evenings it was abundant—a band of 50 or more feeding on flying termites as they come from the ground. They flew from 3 meters to just above the ground catching termites on the wing. The birds were so close that they sometimes collided with each other and two dashed into me.

COLLOCALIA FRANCICA GERMANI Oustalet. Gray-rumped swiftlet.

One male, *Manuel and Rivera.*

This swiftlet was seen going out and coming into the caves that are difficult of access. The tendency of its flight is upward from the cave opening and it is therefore hard to collect. In the cave the bird produces a squeaking note as if injured.

COLLOCALIA ESCULENTA MARGINATA Salvadori. White-bellied swiftlet.

Six males and 2 females, *Manuel and Rivera.*

Very common in Bacuit. Builds nest in caves not far from human habitations. Nest is made of moss with very little gelatinous substance. During early morning and in late afternoon hundreds of birds were seen feeding. They flew not far from the ground, and swooped on small winged insects.

CUCULIDÆ

SURNICULUS LUGUBRIS MINIMUS S. Baker. Glossy drongo cuckoo.

One male and 1 female, *McGregor.*

HIEROCOCCYX SPARVERIOIDES SPARVERIOIDES (Vigors). Large hawk cuckoo.

One male and 1 female, *McGregor.*

CACOMANTIS MERULINUS MERULINUS (Scopoli). Brain-fever bird.

Two females, *McGregor.*

They are smaller than the *C. merulinus merulinus* previously collected, but McGregor considered the size due to immaturity.

Measurements.—Wing, 95 and 97 mm.

EUDYNAMYS SCOLOPACEA PARAGUENA Hachisuka. Palawan koel.

One male, *Manuel and Rivera.*

Not very common in the vicinity of Bacuit. Occasionally heard in second growth, very early in the morning.

CENTROPUS SINENSIS BUBUTUS Horsfield. Common coucal.

One male, *McGregor.*

McGregor notes, "seen once or twice at edge of forest—seems to be rare."

DRYOCOCCYX HARRINGTONI Sharpe. Harrington's cuckoo.

Three males and 8 females, *McGregor;* 4 males, *Manuel and Rivera.*

Our birds were shot in brush patches on the slope of a hill near Bacuit. McGregor notes, "bill emerald green, base of lower mandible blackish—skin in front of and around eye *nopal red,* legs and feet dull steel green—nails black. Seen in forest, often at considerable elevation in trees. Rather shy."

PICIDÆ

DINOPIUM JAVANENSE EVERETTI (Tweeddale). Palawan three-toed woodpecker.

Five males, *McGregor;* 2 males and 2 females, *Manuel and Rivera.*

McGregor notes, "iris brown, tail blackish, lower mandible gray near base, legs and feet dirty courage green." I noted the birds on dead stubs on the hill.

CHRYSOCOLAPTES LUCIDUS ERYTHROCEPHALUS Sharpe. Red-faced golden flicker.

One male and 1 female, *McGregor;* 1 female, *Manuel and Rivera.*

The following were noted by McGregor, "iris carmine, bill bright chalcedony yellow; legs and feet dirty; bill green." Like the three-toed woodpecker, this flicker was noted on dead stubs out of town.

MÜLLERIPICUS PULVERULENTUS PULVERULENTUS (Temm.). Great slaty woodpecker.

One male and 1 female, *McGregor.*

THRIPONAX JAVENSIS HARGITTI Sharpe. Palawan black woodpecker.

Two males and 1 female, *McGregor.*

PITTIDÆ

PITTA SORDIDA SORDIDA (P. L. S. Müller). Black-headed pitta.

One male and 3 females, *Manuel and Rivera.*

Almost invariably heard calling on branches close to the ground.

MUSCICAPIDÆ

HEMICHELIDON GRISEISTICTA GRISEISTICTA Swinhoe. Common gray-spotted flycatcher.

One male and 1 female, *McGregor;* 3 males, *Manuel and Rivera.*

The bird was always observed perched singly on a branch of a tall tree.

CYORNIS LEMPRIERI Sharpe. Palawan blue flycatcher.

Three males and 3 females, *McGregor;* 3 females, *Manuel and Rivera.*

Obtained both on the branch of a tree with scanty leaves in a newly cleared area, and in the thickets close to the ground.

CYORNIS PLATENÆ (Blasius). Platen's flycatcher.

Two males and 1 female, *McGregor.*

McGregor notes, "bill black, legs, feet and nails gull gray."

HYPOTHYMIS AZUREA AZUREA Boddaert. **Black-naped flycatcher.**

Three males, *McGregor;* 1 male and 2 females, *Manuel and Rivera.*

This cheerful bird obviously prefers the underbrush.

RHIPIDURA JAVANICA NIGRITORQUIS Vigors. **Black and white fantail.**

One male, *McGregor.*

XEOCEPHUS CYANESCENS Sharpe. **Large blue flycatcher.**

Two males and 2 females, *McGregor;* 1 male and 1 female, *Manuel and Rivera.*

McGregor records, "in second growth thicket—seems to be very shy."

CULICICAPA HELIANTHEA PANAYENSIS (Sharpe). **Philippine yellow flycatcher.**

One female, *McGregor;* 1 male, *Manuel and Rivera.*

CAMPOPHAGIDÆ

CORACINA STRIATA DIFFICILIS (Hartert). **Palawan cuckoo-shrike.**

One male and 2 females, *Manuel and Rivera.*

PERICROCOTUS IGNEUS Blyth. **Fiery minivet.**

One male, *McGregor.*

PYCNONOTIDÆ

ÆGITHINA TIPHIA AEQUANIMIS Bangs. **Palawan dwarf bulbul.**

Five males and 1 female, *McGregor;* 1 male and 1 female, *Manuel Celestino;* 4 males and 5 females, *Manuel and Rivera.*

Gregarious to some extent. Common in shrubs in the vicinity of Bacuit.

CHLOROPSIS PALAWANENSIS (Sharpe). **Palawan leafbird.**

Nine males and 7 females, *McGregor;* 7 males and 5 females, *Manuel and Rivera;* 1 male and 1 female, *Manuel Celestino.*

Abundant in shrubs near Bacuit.

IRENA PUELLA TWEEDDALII Sharpe. **Palawan fairy bluebird.**

Nine males and 6 females, *McGregor;* 1 male, *Manuel and Rivera.*

McGregor notes, "Male and female strikingly different in colors."

BRACHYPODIUS ATRICEPS ATRICEPS (Temm.). **Black-headed bulbul.**

Fourteen males and 8 females, *McGregor;* 1 male, *Manuel Celestino;* 3 males and 1 female, *Manuel and Rivera.*

CRINIGER FLAVEOLUS FRATER Sharpe. **Gray-throated hairy bulbul.**

Four males and 2 females, *McGregor;* 1 female, *Manuel and Rivera.*

CRINIGER FINSCHII PALAWANENSIS Tweeddale. Palawan hairy bulbul.

Two males, *McGregor;* 2 males and 2 females, *Manuel and Rivera.*

"Iris chalcedony yellow, bill chaetura drab above, lower mandible light neutral gray, legs and nails wood brown to buffy brown."

PYCNONOTUS PLUMOSUS CINEREIFRONS (Tweeddale). Ashy-fronted bulbul.

One male and 3 females, *McGregor;* 6 males and 3 females, *Manuel and Rivera.*

Habits and call note similar to those of *P. goiavier.* Commoner near town than in country. Scarcely seen in forest. Iris dark brown.

TIMALIIDÆ

MALACOCINCLA RUFIFRONS (Tweeddale). Rufous-headed babbler.

Three males, *McGregor.*

PTILOCICHLA FALCATA Sharpe. Palawan ground babbler.

One male, *McGregor.*

ANUROPSIS CINEREICEPS (Tweeddale). Ashy-headed wood babbler.

One male and 2 females, *McGregor.*

"Iris claret brown. On the ground in underbrush. Very quick and somewhat shy."

MIXORNIS FLAVICOLLIS WOODI Sharpe. Palawan tit babbler.

Two males and 2 females, *McGregor;* 1 male and 4 females, *Manuel and Rivera.*

"Iris isabella color—lower mandible light Payne's gray—upper mandible dark Payne's gray, almost black on culmen—legs, feet and nails light yellowish olive. Single bird usually in low growth."

TURDIDÆ

MONTICOLA SOLITARIA PHILIPPENSIS (P. L. S. Müller). Eastern rock thrush.

Two females, *Manuel and Rivera.*

Found singly on rock along shore.

SYLVIIDÆ

KITTACINCLA NIGRA (Sharpe). Palawan black shama.

Fifteen males and 4 females, *McGregor;* 5 males and 1 female, *Manuel and Rivera.*

"This species acts more like *Copsychus* than like *K. luzoniensis* and other Philippine shamas. The Palawan bird is seen in hedges and 2nd growth thickets near town and is not quick to take alarm."

ORTHOTOMUS RUFICEPS NUNTIUS Bangs. Palawan tailorbird.

Five males and 2 females, *McGregor;* 5 males and 3 females, *Manuel and Rivera.*

"Fairly common in thickets near settlement." Like other tailorbirds, it has several call notes.

PHYLLOSCOPUS BOREALIS BOREALIS (Blasius). Northern willow warbler.

Two males, *McGregor.*

ARTAMIDÆ

ARTAMUS LEUCORYNCHUS LEUCORYNCHUS (Linn.). White-bellied swallow shrike.

One male and 2 females, *Manuel and Rivera.*

Common near settlements and on hills, conspicuously perched on clear branches.

LANIIDÆ

LANIUS CRISTATUS LUCIONENSIS Linn. Philippine red-tailed shrike.

Two males, *McGregor;* 1 male and 1 female, *Manuel and Rivera.*

Rare in Bacuit during the latter part of April.

PACHYCEPHALA WHITEHEADI (Sharpe). Palawan thickhead.

One male and 1 female, *McGregor.*

PARIDÆ

PARUS AMABILIS Sharpe. Palawan tit.

Three males and 4 females, *McGregor;* 1 male and 1 female, *Manuel and Rivera.*

SITTIDÆ

CALLISITTA FRONTALIS PALAWANA (Hartert). Palawan nuthatch.

One female, *McGregor;* 2 males and 2 females, *Manuel and Rivera;* 1 male, *Manuel Celestino.*

"Bill scarlet, tip of upper mandible dusky—iris clear yellowish green, skin around eye yellowish oil green—legs dark liver brown—nails blackish brown."

DICÆIDÆ

DICÆUM SANGUINOLENTUM PYGMÆUM (Kittlitz). Pygmy flowerpecker.

Two males and 1 female, *McGregor.*

PRIONOCHILUS JOHANNÆ Sharpe. Palawan flowerpecker.

Twenty-five males and 12 females, *McGregor;* 2 males and 1 female, *Manuel and Rivera.*

PIPRISOMA AFFINIS (Zimmer). Palawan rusty flowerpecker.

Four males, *McGregor.*

The specimens were compared with those from Luzon, and a difference was noted particularly in the color of the upper parts. Zimmer(20) first described this bird as *Acmonorhynchus affinis,* which Riley(12) apparently overlooked when he described *Piprisoma diversum.*

NECTARINIIDÆ

CHALCOSTETHA CHALCOSTETHA (Jardine). Copper-breasted sunbird.

Four males and 1 female, *McGregor;* 1 male, *Manuel Celestino;* 7 males and 1 female, *Manuel and Rivera.*

"Abundant in mangroves—feet black, soles light orange yellow."

ÆTHOPYGA SHELLEYI Sharpe. Shelley's sunbird.

Two males, *McGregor;* 1 male, *Manuel Celestino;* 6 males, *Manuel and Rivera.*

Observed occasionally in thickets where a few pairs may be noted leaping from twig to twig.

LEPTOCOMA BRAZILIANA SPERATA (Linn.). Red-breasted sunbird.

Two males, *McGregor;* 1 male, *Manuel Celestino.*

LEPTOCOMA JUGULARIS AURORA (Tweeddale). Orange-breasted sunbird.

Fourteen males, *McGregor;* 1 male and 1 female, *Manuel Celestino.*

Common on coconut trees. A pair was observed in Bancalen building a nest inside a house situated in a coconut grove.

ANTHREPTES MALACCENSIS PARAGUAE Riley. Palawan brown-throated sunbird.

Twenty-one males and 7 females, *McGregor;* 1 male, *Manuel Celestino;* 2 males, *Manuel and Rivera.*

ARACHNOTHERA LONGIROSTRA DILUTIOR Sharpe. Pale spider hunter.

Four males and 1 female, *McGregor;* 3 males and 1 female, *Manuel Celestino.*

"Feeding on flowers of papaya. A. Celestino says it feeds on banana flowers."

MOTACILLIDÆ

MOTACILLA OCULARIS Swinhoe. Streak-eyed wagtail.

One female, *Manuel Celestino.*

MOTACILLA MELANOPE Pallas. Gray wagtail.

Two males, *McGregor;* 1 female, *Manuel and Rivera.*

MOTACILLA FLAVA SIMILLANA Hartert. Siberian yellow wagtail.

One male and 1 female, *McGregor.*

PLOCEIDÆ

UROLONCHA LEUCOGASTRA EVERETTI (Tweed.). Everett's weaver.

One male, *Manuel and Rivera.*

ORIOLIDÆ

ORIOLUS CHINENSIS CHINENSIS Linn. Philippine oriole.

Three males and 2 females, *Manuel and Rivera.*

Apparently not as abundant in Palawan as in Luzon.

ORIOLUS XANTHONOTUS PERSUASUS Bangs. Palawan black-headed oriole.

Four males and 3 females, *McGregor.*

"Very distinct from other Philippine forest orioles—much commoner and bolder."

DICRURIDÆ

DICRURUS HOTTENTOTTUS PALAWANENSIS Tweeddale. Palawan drongo.

Five males and 8 females, *McGregor;* 3 males and 3 females, *Manuel and Rivera;* 1 male, *Manuel Celestino.*

Fairly common in second growth.

DICRURUS LEUCOPHÆUS PALAWANENSIS (Whitehead). Palawan drongo.

One male and 1 female, *McGregor;* 2 males and 2 females, *Manuel Celestino;* 1 male and 2 females, *Manuel and Rivera.*

STURNIDÆ

STURNIA PHILIPPENSIS (Forster). Violet-backed starling.

One male and 1 female, *Manuel and Rivera.*

APLONIS PANAYENSIS PANAYENSIS (Scopoli). Philippine glossy starling.

Two males and 1 female, *McGregor;* 4 males and 2 females, *Manuel and Rivera.*

Small flocks were common on trees near cleared areas.

GRACULA JAVANA PALAWANENSIS (Sharpe). Palawan wattled myna.

Two males and 2 females, *McGregor;* 1 male and 1 female, *Manuel and Rivera.*

Feeding on fruits. Not very common. Generally in pairs, occasionally forming small flocks.

CORVIDÆ

CORVUS ENCA PUSILLUS Tweeddale. Little crow.

One male *McGregor;* 2 males and 2 females, *Manuel and Rivera.*

Common on hills, from where its caw-caw-like call may be heard at a distance below.

RESUMÉ OF THE KNOWN BIRDS OF PALAWAN

The above list includes 94 forms, recently collected from Palawan Island and now in the collection of birds of the Philippine Bureau of Science. This collection includes the 70 forms collected by R. C. McGregor and party in Puerto Princesa in 1925; 18 forms collected by Manuel Celestino in Taytay in 1934; and 59 forms collected by Francisco S. Rivera and me in Bacuit and vicinity in 1936. *Gelochelidon nilotica nilotica, Ninox scutulata scutulata, Collocalia francica germani, Collocalia esculenta marginata,* and *Piprisoma aeruginosum* represent additional records for this island. With *Pitta persola* Brodkorb and *Piprisoma affinis* (Zimmer) held valid, there will have been recorded from Palawan 197 forms.

BIRDS RECENTLY COLLECTED FROM BUSUANGA

Busuanga is the largest island in the Calamianes group. It is situated northeast of Palawan to which it is zoögeographically allied. In addition to what Worcester and Bourns(19) had mentioned about this island, Manuel Celestino, who collected the birds reported below, notes that Busuanga is topographically rugged. In the immediate vicinity of Coron, where M. Celestino did a little collecting at intervals while enforcing the fish and game laws, there are many cleared areas near hillsides. Towards the interior and not far from Coron are high mountains. Bamboo thickets are common on the hills and on the plain. Due to the very limited time devoted to actual collecting, only the 22 forms of birds listed below were obtained.

MACROPYGIA PHASIANELLA TENUIROSTRIS Bonaparte. Slender-billed cuckoo dove.

One male.

STREPTOPELIA CHINENSIS PALAWANA Hachisuka. Palawan spotted dove.

One male and 1 female.

NYCTICORAX NYCTICORAX NYCTICORAX (Linn.). Common night heron.

One male.

FALCO TINNUNCULUS DORRIESI (Swann). Kestrel.

One female.

STRIX SELOPUTO WIEPKENI (Blasius). Palawan wood owl.

One male and 1 female.

PRIONITURUS DISCURUS PLATENÆ (Blasius). Palawan racket-tailed parrakeet.

One male and 6 females.

TANYGNATHUS LUCIONENSIS LUCIONENSIS (Linn.). Philippine green parrot.

Two males and 3 females.

CEYX RUFIDORSUS Strickland. Red-backed three-toed kingfisher.

Three males.

GYMNOLÆMUS LEMPRIERI (Sharpe). Palawan hornbill.

One female.

DRYOCOCCYX HARRINGTONI Sharpe. Harrington's cuckoo.

One male.

DINOPIUM JAVANENSE EVERETTI (Tweeddale). Palawan golden-backed three-toed woodpecker.

Two males and 1 female.

HEMICHELIDON GRISEISTICTA GRISEISTICTA Swinhoe. Gray-spotted flycatcher.

One female.

CHLOROPSIS PALAWANENSIS (Sharpe). Palawan leafbird.

Two males and 3 females.

ORTHOTOMUS RUFICEPS NUNTIUS Bangs. Rufous-headed tailorbird.

One male.

PRIONOCHILUS JOHANNÆ Sharpe. Palawan flowerpecker.

One male and 1 female.

ÆTHOPYGA SHELLEYI Sharpe. Shelley's sunbird.

One male.

LEPTOCOMA JUGULARIS AURORA (Tweeddale). Orange-breasted sunbird.

Two males.

ANTHUS RICHARDI LUGUBRIS Walden. Indian pipit.

Two females.

ORIOLUS CHINENSIS CHINENSIS Linn. Philippine oriole.

Two females.

DICRURUS HOTTENTOTTUS CUYENSIS McGregor. Cuyo drongo.

Two males and 1 female.

DICRURUS LEUCOPHÆUS PALAWANENSIS (Whitehead). Palawan gray drongo.

Two females.

GRACULA JAVANA PALAWANENSIS (Sharpe). Palawan wattled myna.

One female.

RESUMÉ OF THE KNOWN BIRDS OF BUSUANGA

The above list contains 22 forms of birds obtained from Busuanga Island by Manuel Celestino. If the 80 forms recorded by Worcester and Bourns(19, p. 569) were all taken from this island, 4 forms are recorded for the first time from Busuanga. The new records for this locality are *Macropygia phasianella tenuirostris*, *Nycticorax nycticorax nycticorax*, *Falco tinnunculus dorriesi*, and *Strix seloputo wiepkeni*. These birds have been recorded both in Luzon and in Palawan, except *N. n. nycticorax* which has not been reported from Palawan. Further collecting in Busuanga will doubtless yield additional forms heretofore unrecorded.

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7. MANUEL, C. G. Beneficial swiftlet and edible birds' nest industry in Bacuit, Palawan. Philip. Journ. Sci. 62 (1937) 379–391, 3 pls.
8. MCGREGOR, R. C. On birds from Luzon, Mindoro, Masbate, Ticao, Cuyo, Culion, Cagayan, Sulu, and Palawan. Bull. Philip. Mus. 1 (1903) 1–12.
9. MCGREGOR, R. C. Notes on a collection of birds from Palawan Island. Philip. Journ. Sci. 1 (1906) 903–908.
10. MCGREGOR, R. C. A Manual of Philippine Birds. 2 pts. (1909) x + 769 pp.
11. MEARNS, E. A. Two additions to the avifauna of the Philippines. Philip. Journ. Sci. § A 2 (1907) 353.
12. RILEY, J. H. A new flower-pecker from Palawan Island, Philippines. Proc. Biol. Soc. Wash. 49 (1936) 113, 114.
13. SHARPE, R. B. On a collection of birds made in Southern Palawan by Mr. E. Lempriere. Ibis (1884) 316–322, pl. 8.
14. SHARPE, R. B. On the birds collected by Prof. J. B. Steere in the Philippine Archipelago. Trans. Linn. Soc. London (1877) 307–356, 9 pls.
15. SHARPE, R. B. On a collection of birds from the island of Palawan. Ibis (1888) 193–204, pls. 3, 4.

16. STEERE, J. B. Ornithological results of an expedition to the Philippine Islands in 1887 and 1888. Ibis (1891) 302.
17. TWEEDDALE, ARTHUR MARQUIS OF. Contributions to the ornithology of the Philippines. No. IX. On the collection made by Mr. A. H. Everett in the island of Palawan. Proc. Zoöl. Soc. London (1878) 611–624, pls. 37, 38.
18. WHITEHEAD, J. Notes on the birds of Palawan. Ibis (1890) 38–61, 2 pls.
19. WORCESTER, D. C., and F. S. BOURNS. Contributions to Philippine ornithology. Proc. U. S. Nat. Mus. 20 (1898) 549–625, pls. 55–61.
20. ZIMMER, J. T. Some notes on the birds of southern Palawan and adjacent island. Philip. Journ. Sci. § D 13 (1918) 327–357.

ILLUSTRATION

PLATE 1

A patch in deep forest supposedly cleared by the Palawan peacock pheasant.

PLATE 1. A patch in deep forest supposedly cleared by the Palawan peacock pheasant.

BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

The Pharceutical Pocket Book. Published by Direction of the Council of the Pharmaceutical Society of Great Britain. London, The Pharmaceutical Press, 1938. 13th ed. 370 pp. Price, 5s.

This small volume consisting of 370 pages contains varied information that has surpassed the original intent of those responsible for the publication of the first edition which appeared in 1906 under the title of Pharmacy Students' Pocket Note-Book, 1906, because the volume is now rich in data that are useful not only to students of pharmacy but to practitioners as well.

The contents of previous editions were brought up to date and rearranged. The section on "Science and Art of Dispensing" which gives useful hints in compounding and dispensing medicines has been substantially rewritten and enlarged. A new section dealing with the new Poisons Law in Great Britain "gives a general outline of the principal provisions of the Pharmacy and Poisons Act, 1933, and the Poison Rules, 1935, as amended by the Poisons (Amendment) Rules, 1937, in so far as they affect the Pharmacists."—P. V.

Child Care and Training. By Marion L. Faegre and John E. Anderson. Minneapolis, The University of Minnesota Press, c1937. 4th ed. rev. 327 pp., illus. Price, $2.50.

There is a saying that theorizing about bringing up children is of no use, because by the time you begin to study the results of your theories, the children have grown up and new theories have sprung into existence. The trouble lies, of course, in the fact that you can have only one set of children on which you can set your ideas to work; for even if you live to see your children's children, you would not have a hand in bringing up the new generation. Not a welcome hand, because human nature being what it is, your grown children will have their own ideas about bringing up their own offspring.

What you need, apparently, is about five centuries in which to work out different experiments in order to find the best way of rearing babies, but at the end of five centuries, where are you?

Child Care and Training, by Faegre and Anderson, solves the problem. It incorporates for you what your five centuries can give you, all the best methods, past and present, for the care of children. All that is sane and sound—no fads and nonsensical novelties—about rearing children to health and happiness is put forth in understandable excellent style. The general reader may look into the book and gain some grains of truth, the parent may find guidance for his child—a problem child, or himself—a problem parent. And for parents-to-be, the book is a handy, practical reference to what lies before them.

Exceptionally well-organized, the chapters cover every phase of growing childhood, beginning with birth, and logically ending with the child as a grown unit of the family, having grown up physically, emotionally, mentally, and socially.

Written without brilliancy, but with clearness and ease, without too many technicalities but with a fine sense of childhood psychology, Child Care and Training is one of the really fine, useful books a person may own.—F. H. R.

The Treatment of Malaria; Study of Synthetic Drugs, as compared with Quinine, in the Therapeutics and Prophylaxis of Malaria. Fourth General Report of the Malaria Commission, and Appendices. Geneva. League of Nations Health Organization. 1937. 558 pp. Price, $0.65.

Based upon experiments conducted in Algeria, Italy, the Malay States, Roumania, and the Union of Soviet Socialist Republics, the Fourth Report, one would expect, ought to receive a warmer reception than what was accorded to its predecessor, "Therapeutics of Malaria," issued by the Commission in 1933. Involving a method exactly alike in all cases, but applied under different climates, species of insect vectors, strains of malaria parasites, human race, social grades, standards of living, and other factors, the experiments upon which the Fourth Report is based evidently attempted to eliminate the main objections raised against the 1933 report. It has been alleged, among others, that the Third Report arrived at ". . . too many general conclusions on the basis of results obtained in laboratory cases."

After a critical analysis of the results manifested by quinine, atebrin, plasmoquine, and various combinations of these drugs on trophozoites, gametocytes, acute clinical symptoms, frequency of relapses, splenomegaly, and the general health of the patient, the Commission gives some practical suggestions for malaria treatment and prophylaxis. It believes that for ordinary infection of benign tertian, quinine is just as efficacious as atebrin, and that plasmoquine administered either with, or after, quinine or atebrin does not have any appreciable effect on the attack, although the frequency of subsequent relapses seems to be reduced. For malignant tertian infection, however, plasmoquine given together with quinine, or after atebrin, not only reduces relapses but has also a decided effect on the gametocytes. Collective treatment in the field with quinine or atebrin may, likewise, be advantageously accompanied or followed by plasmoquine so as to lessen relapses and reduce the number of gametocytes. Quinine, administered for collective treatment in daily doses of 1 to 1.30 g (for adults) for five to seven days or more, is similar in effect to atebrin given in daily doses of 0.30 g for five to seven days. For mass drug prophylaxis quinine in daily doses of 0.40 g, administered during the season of transmission, is claimed superior to a daily dose of 0.05 g of atebrin. Quinine, moreover, has the advantage of being cheaper, while its almost complete harmlessness allows it to be administered by subordinate personnel. Atebrin and plasmoquine, on the other hand, should be given under direct medical supervision. Their drawbacks, furthermore, are the production of yellow coloration on the skin by atebrin, and the toxicity of plasmoquine; if administered simultaneously the toxicity of each of these drugs appears to become aggravated.

The Commission still holds the opinion that up to the present no drug is yet known which can be safely and effectively used as a sporozoiticidal prophylaxis against malaria. Likewise, it believes that the eradication of malaria from a locality by curative and prophylactic treatment is impossible, since these methods cannot suppress the parasites in all carriers, although they may greatly diminish the morbidity.

—SECTION OF MALARIA CONTROL, BUREAU OF HEALTH.

Diseases and Surgery of the Dog; Alphabetically arranged. By Raymond J. Garbutt. New York, Orange Judd Publishing Company, Inc. 1938. 332 pp. Price, $3.50.

This book is a valuable treatise, embracing practically all the diseases and surgical conditions with which the canine family is afflicted. Written by one of the leading veterinarians of America who counts with a long experience and an extensive practice in the large hospital of the American Society for the Prevention of Cruelty to Animals, this book will be highly informative to the veterinary practitioner, especially the discussion on the treatment and management of canine fractures. The chapter on canine feeding will be of special interest to the kennel breeder. The book is profusely illustrated, and where technical terms are used they are well explained in a language easily understood by the novice.

Like any other book in first edition, this book is not free from error. The latter, however, are not very grave, and, by and large, do not diminish the value of the text.

This book will be a valuable addition to the library of anyone interested in the study of kennels.—P. G. R.

The Construction of Vulcanite Applicators for Applying Radium to Lesions of the Buccal Cavity, Lips, Orbit and Antrum. By Desmond Greer Walker. Foreword by W. Warwick James. London, Published for the Middlesex Hospital Press by John Murray, 1938. 61 pp., illus. Price, 5s.

The author described with ample illustrations a new method of constructing a vulcanite applicator for applying radium to tumors found in the oral cavity, lips, orbit, and antrum. It is claimed that this applicator not only facilitates the proper distribution of radium irradiation during treatment, but also protects the neighboring tissues from the harmful secondary irradiation. In other words, this vulcanite applicator not only serves as an appliance to carry the radium needles to the desired location but also acts as a filter to the undesirable soft rays. Ingenious devices for the retention of the applicator during treatment, with maximum efficiency and comfort to the patient, are also included in the description. The vulcanite applicator can easily be constructed in a dental laboratory in collaboration with the physician dealing with radium therapy. This book is a very handy reference for dentists and radium therapists.

—V. G. V.

Punishment; its Origin, Purpose and Psychology. By Hans Von Hentig. London, William Hodge and Company, Ltd., 1937. 239 pp. Price, 12s 6d.

Few books have been written on the subject of punishment, and this one by the world-famous German criminologist, Hans von Hentig, is easily the most interesting. Originally written in German, it was translated into English for the English-speaking world.

In simple language and delightful style the author presents the origin, purpose, and psychology of punishment. With characteristic German thoroughness he discusses in five chapters the scope and limits, evolution, mental classification, means, and finally the development and future of punishment.

"Punishment," the author defines, "is organized hurt, an impairment of life organized in the form of laws, which society consciously uses to train humanity to avoid certain possible courses of action potentially injurious or hostile to itself."

Especially interesting is the chapter on the evolution of punishment, where the author takes us through the different forms and origins of punishment. The various means of punishment are also discussed, and of these probably the one that should attract the reader's attention most is the sterilization and castration of criminals. This means should be of especial interest to penologists and criminologists, in view of practices recently introduced in Germany and in some States in America, wherein castration and sterilization are mandatory for persistent offenders against morality.

Is castration abstractly a preventive measure or a punishment? The author answers with the rather cryptic remark, "The history of penal law shows that practically every organ which at one time or another was regarded as the seat of the soul or life force, the head, heart, blood and phallus, has also been the object of attack of penal law."

The readers can guess the author's stand on the problem of sterilization and castration, but if they cannot, they ought to read this most interesting book. Penologists, criminologists, psychologists, and sociologists—all students of crime and its prevention, should not fail to read von Hentig's work. The few hours spent going through the 239 pages will be well repaid.

—S. G. P.

Statistical Methods; Applied to Experiments in Agriculture and Biology. By George W. Snedecor. Ames, Iowa, Collegiate Press, Inc. 1938. 388 pp. Price, $3.75.

For those who have little or no knowledge of mathematics beyond arithmetic, this book gives the proper approach to the analysis and the interpretations of experimental results obtained in the fields of biology and agriculture. Without the use of elaborate mathematical analyses and formulas which characterize books on this subject, the interpretations and analyses of experimental data in biology and agriculture are well presented. Even such subjects as poison and binomial distributions for large samples, and curvilinear regressions, all of which are mathematical in nature, are treated in a nonmathematical manner. The general method throughout the book has been made concrete by a wealth of applications and examples drawn mainly from the fields of agriculture and biology.

The development of the subject is logical, experiments involving one variate being fully treated first, giving due emphasis to computations of statistical parameters, such as the "measure of variability" (x^2, chi-square), and "test of significance." The mutual relationships of more than one variate in one or more groups are fully discussed, giving rise to such concepts as linear and nonlinear regressions, variance and covariance, correlation and partial correlation coefficients, and the like. These concepts are being introduced as they are needed in dealing with experimental data.

Mention may be made of the following special features of the book: The chapter on "short-cut" methods of computing statistical parameters, with reference to the use of adding machines, and the criteria in deciding how many significant digits are to be carried during the process of computations; second, the chapter entitled "Individual Degrees of Freedom," in which are introduced new ideas about comparison of means, and new methods of computing "test of significance;" for instance, devices for rapid calculation of mean squares from two means represented by two sums. Adequate references are given at the end of each chapter. Furthermore, because of the presentation and arrangement of the subject matter, the book is useful for a short course in statistical methods for biological and agricultural students.

The book as a whole is highly recommended as a practical aid to experimental workers, especially in the fields of biology and agriculture, who are in need of proper interpretation of the results of their experiments. Outside the fields for which it was written, this book is designed not for all students but only for those who are already acquainted with the subject of statistics and are only looking for statistical methods. The fact that examples and illustrations are drawn mostly from experiments in biology and agriculture makes the book useful only to those sciences.—T. J. J.

Mother Earth; Being Letters on Soil addressed to Professor R. G. Stapledon. By Gilbert Wooding Robinson. London. Thomas Murby & Co. 1937. 202 pp. Price, 5s 6d.

This book gives a clear description of the soil in its natural state and a discussion of different conditions and treatments of soil. The main object is to present the entire soil conditions and the different factors governing the improvement of the land for agriculture. Among the topics discussed in detail are humus, soil moisture, fertility, and soil amendments. The discussion under structure and tilth gives valuable data. Under soil surveys fundamental data for practical and scientific purposes are very concisely discussed.

The author emphasizes the need for proper soil management in order to maintain the crop-producing power of the land and to avoid the tremendous amounts of waste lands resulting from soil erosion. Land highly eroded cannot be reclaimed for agricultural purposes for a number of years. This point is strongly emphasized so that farmers should try their best to avoid the occurrence of soil erosion. There is a tendency among farmers to deplete and wear out the surface soil. High production always robs the soil of its fertility. The farmer should exert all efforts to continually replace what has been removed from the soil.

This book is written in the form of letters to all those who are in direct contact with Mother Earth upon whom our daily existence depends. It should be read by everybody regardless of vocation.—M. M. A.

Petroleum Technology. 1935. London. The Institution of Petroleum Technologists, 1936. 263 pp. Price, 7s 6d.

One in search of a book that would keep him abreast with the progress and developments of the whole science of naphthology will not only find in this book the very thing he desires, but will also be impressed that such a broad subject can be presented in so concise yet comprehensive a manner. This book consists of twenty-four articles, each presenting a review and descriptions of recent developments on the different phases or activities in petroleum technology. The book contains a total of 1,927 cited references. Included among the articles are those on geology and geophysics of petroleum; refining and cracking; lubricants and lubrication; asphalt and road materials; special products, like cutting oils, sulphonated oils, special lubricants, insecticides, medicinal oils, and the like; analysis and testing of petroleum products; chemistry of petroleum; production technic; and statistics on world productions of petroleum.—I. P.

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CARPENTER, J. RICHARD. An ecological glossary. Norman, Oklahoma, University of Oklahoma Press, 1938. 306 pp., appendix. Price, $4.

FAEGRE, MARION L., and JOHN E. ANDERSON. Child care and training. 4th ed. rev. Minneapolis, The University of Minnesota Press, 1937. 327 pp., front., pictures. Price, $2.50.

GARBUTT, RAYMOND J. Diseases and surgery of the dog; alphabetically arranged. New York, Orange Judd Publishing Company, inc. 1938. 332 pp., illus. Price, $3.50.

HOLLAND, W. L., and KATE L. MITCHELL. Problems of the Pacific, 1936. Aims and results of social and economic policies in Pacific countries. Proceedings of the sixth conference of the Institute of Pacific Relations, Yosemite National Park, California, August 15–29, 1936. Chicago, University of Chicago Press. 470 pp. Price, $5.

Laws relating to birth control in the United States and its territories. New York, Birth control research bureau, 1938. 61 pp. Price, $0.25.

LORD, FREDERICK T., and RODERICK HEFFRON. Pneumonia and serum therapy. Revised edition of lobar pneumonia and serum therapy. New York, Commonwealth Fund, 1938. 148 pp., illus. Price, $1.

Medical education in the United States and Canada. Thirty-eighth annual presentation of educational data by the Council of Medical Education and Hospitals of the American Medical Association for the Session 1937–1938. Reprinted from the education number of the Journal of the American Medical Association, August 27, 1938. 850 pp.

NEUBECKER, WILLIAM. Sheet metal work. A manual of practical self-instruction in the art of pattern drafting and construction work in light and heavy-gauge metal, including skylights, roofing, cornice work, patterns for forced-air fittings, etc. Chicago, American Technical Society, 1938. 360 pp., illus. Price, $2.50.

Pacific Northwest Chemurgic conference with Washington State Planning Council, Spokane, Washington, March 22 and 23, 1937, to advance the industrial uses of crops of the Pacific Northwest's farms and forests through applied science. Published by Ernest M. Hutchinson, Secretary of State, August, 1937. 134 pp.

Pharmaceutical pocket book. 13th ed. Published by direction of the council of the Pharmaceutical society of Great Britain. London, The Pharmaceutical press, 1938. 370 pp. Price, 5s.

PATERSON, DONALD. Sick children: diagnosis and treatment. A manual for students and practitioners. 3d ed. rev. London, Cassell and Company ltd., 1938. 604 pp., illus. Price, 12s 6d.

POTTER, MORGAN H. Electric welding; a practical text covering the fundamental principles and applications of the various types of electric arc welding, including the use of power tube rectifiers. Chicago, American Technical Society, 1938. 125 pp., frontis., illus. Price, $1.25.

ROBINSON, GILBERT WOODING. Mother earth, being letters on soil addressed to Professor R. G. Stapledon. London, Thomas Murby & Co., 1937. 202 pp. Price, 5s 6d.

SCHUSTER, JULIUS. Zur Entdeckung der Insulinschocktherapie bei akuten Geisteskrankheiten, insbesondere bei der Schizophrenie. Budapest, Paster Lloyd-Gesellschaft. 90 pp. Price, 2 pengo.

SNEDECOR, GEORGE W. Statistical methods applied to experiments in agriculture and biology. Ames, Iowa, Collegiate Press, inc., 1938. 388 pp., illus. Price, $3.75.

WINSLOW, C. E. A., and others. A survey of methods of care, treatment, and training of the feebleminded, together with a program for the future. Made at Letchworth Village Thiells, New York. Utica, New York, State Hospitals Press, 1937. 164 pp., illus.